THE ENGINEER

A Seven-Day Journal

The Coal Situation

A STATEMENT made in London on Tuesday last by Mr. A. Robens, Parliamentary Secretary to the Ministry of Fuel and Power, emphasised that increasing consumption of coal, combined with a fall in manpower which offset improved output per manshift and improved attendance in the mines, had brought Great Britain face to face with the possibility of a coal shortage within the next two months. Mr. Robens said that the rise in inland coal consumption in 1950, as compared with 1949, occurred in all the main consumption groups except the railways. Increased production last year did not keep pace with the rise in consumption, with the result that at the end of the year distributed coal stocks were 12,452,000 tons, or about 2,300,000 tons less than at the end of 1949. The latest figures from the Ministry of Fuel and Power showed that, in the week ended January 13th, stocks had been reduced to 11,007,000 tons, compared with 13,794,000 tons on the corresponding date last year. In the first three weeks of this year, Mr. Robens reported, coal stocks at electricity generating stations had fallen from 3,038,000 tons to 2,577,000 tons, or from 3·9 weeks' to 3·3 weeks' supply. Although a figure of 11,000,000 tons for stocks seemed impressive it did not, in fact, amount to a great deal when spread over the whole field of heat and power supplies, and the immediate need was to conserve coal stocks by every possible means. Mr. Robens added that a committee of the National Production Advisory Council for Industry was keeping a careful watch on the situation, and although no reduction in industrial allocations had yet been made, there were already some instances of "under-delivery." It was not intended, however, to make any reduction in supplies to power stations. Saleable output of coal from the deep mines last week amounted to 4,237,400 tons, which, with 165,400 tons from opencast workings, gave a total production for the week of 4,402,800 tons.

Institution of Mechanical Engineers

AT a general meeting of the Institution of Mechanical Engineers on Friday evening last, it was announced that Mr. Brian G. Robbins, M.Sc.(Eng.), A.C.G.I., M.I.Mech.E., had been appointed secretary of the Institution in succession to Sir Henry Guy, C.B.E., F.R.S., who has retired from that office on account of indifferent health. Mr. Robbins was educated at Christ's Hospital and at the City and Guilds (Engineering) College. After obtaining his degree, he gained an Unwin Scholarship for research work and was awarded the Diploma of the Imperial College. He spent four and a half years with Vauxhall Motors, Ltd., where he obtained workshop training and planning office experience, and in 1927 became the assistant secretary of the Institution of Automobile Engineers. In 1934, Mr. Robbins was appointed secretary of the "Automobiles" in succession to the late Mr. Basil Joy. During the second World War, Mr. Robbins served first with the Royal Army Service Corps, and subsequently with the Directorate of Military Training. Later, he was posted to Western Command H.Q., and was released from R.E.M.E. in the autumn of 1945 with the rank of Lieutenant-Colonel. Upon the amalgamation of the Institution of Automobile Engineers with the Institution of Mechanical Engineers in 1947, Mr. Robbins became an assistant secretary of the "Mechanicals," taking responsibility for the Automobile Division and, for a time, acting as the Institution's education officer. It was also announced on Friday that Mr. C. W. J. Taffs, M.I.Mech.E., had retired from the position of assistant secretary of the Institution, which office he has held since 1941. Mr. Taffs joined the Institution staff in 1921 as research assistant, and has been particularly concerned with the work of the Publications and Library Committee, Research Advisory and other committees. His successor as assistant secretary is Mr. G. H. Ford, M.Sc., who, for some years, has had charge of the Institution's membership department.

The Institute of Refrigeration

To celebrate its fifty-first anniversary, the Institute of Refrigeration held a dinner at the Savoy Hotel, London, on Wednesday, January 17th. The President, Viscount Bruce of Melbourne, was in the chair and a large company of members and guests was present. In proposing the toast "The Institute of Refrigeration," the Honourable E. J. Harrison, Resident Minister in London for the Commonwealth of Australia, mentioned that this year was the fiftieth anniversary of federation in Australia and he stressed the benefits which refrigeration had brought to Australia by making many parts habitable and by assisting in the development of foodstuffs for export. He dwelt on the theme of the Empire being a family and stated that expansion in Australia was closely related with development in Britain, instancing the £150,000,000 of new capital which had been invested in that country and extending a welcome to the 100,000 emigrants who were expected this year. Referring to the international situation, Mr. Harrison emphasised that the Empire should speak with one voice, and to that end advocated the setting up of a London committee to co-ordinate defence policy. Viscount Bruce of Melbourne replied for the Institute and announced that the King had graciously assented to be Patron of the Eighth International Congress of Refrigeration, which was to be held in London this year. The toast, "Science and Industry," was given by Major-General C. Lloyd, who said that present day endeavours were directed to forming an efficient link between the pure scientist, who should be untrammelled by fundamentals, and the technologist, who was in close contact with industry. Lord Dudley Gordon, replying on behalf of industry, stressed future difficulties likely to arise from scarcity of raw materials, and regretted the certain disruption in a basic industry due to the Iron and Steel Act. Linking the Government, as being the biggest spender, with inflation, Lord Dudley called attention to the fact that increased productivity had only occurred in firms under private ownership. Professor F. E. Simon responded for science and made a plea for a better place in industry for the scientist.

Proposed Transport Museum

THE British Transport Commission has accepted in principle the suggestion of a committee that a permanent transport museum should be created and housed in Nine Elms Station, London. The committee was set up as a result of an invitation given by the British Transport Commission in 1947 to the chairman of the main line railway companies and the London Passenger Transport Board to express their views as to the best means of dealing with the collections of relics and records in their possession and which would pass to the Commission on January 1, 1948. At a meeting, which took place following the invitation, it was generally agreed that the creation of the British Transport Commission presented an excellent opportunity for the formation of a comprehensive transport collection, of which a substantial nucleus was already available. The independent canal companies and the long-established road transport concerns formerly owned by the railway companies were requested to ensure that all historical items would be preserved carefully. Similar steps were taken by the Commission's executives, which made arrangements for existing lists and catalogues to be brought up to date and much preliminary work was carried out in 1948 and 1949. Amongst the leading recommendations made by the committee for the first stage in the creation of the museum is that the York railway museum should remain but should be devoted to railway exhibits from the North of England. It is also considered that the Scottish collection at Edinburgh should remain and later be enlarged by the inclusion of small transport exhibits from the railways, canals, roads and docks. This collection, it is suggested, should, when appropriate, be opened to the public as the British Transport Museum, Edinburgh. At a later date consideration should be given to forming a collection of Welsh transport exhibits in Cardiff. The selection of the old London and Southampton Railway terminus at Nine Elms as a permanent museum was prompted by the fact that it was considered to be probably the finest medium-sized train shed of the early railway period—with most of its original architecture—now surviving in this country.

Lloyd's Register Shipbuilding Returns

THE returns for the quarter ended December 31, 1950, issued by Lloyd's Register of Shipping, show that 330 steamers and motorships, of 2,044,688 tons gross, were under construction, being 1546 tons less than the previous quarter, of which seventy-six ships were afloat, the remainder being still to launch. During the quarter eighty-four ships, of 389,502 tons, were laid down, fifty-five ships of 317,750 tons were launched, seventy-seven ships of 393,481 tons were completed and 1880 tons were suspended. Ships being built for abroad amounted to 118 of 794,638 tons, that is 31,107 tons less than in September last and represented 38·9 per cent of the tonnage being built in this country. Oil tankers over 1000 tons under construction increased by 36,024 tons over the last quarter to total ninety-seven ships of 1,146,364 tons, thus forming 56·1 per cent of the total tonnage building in this country. Plans were approved and material ordered for 148 ships of 954,486 tons, of which 70 per cent were oil tankers. Abroad, 839 ships of 2,774,065 tons gross were under construction, a decrease of 18,846 tons on September last. Figures are not available for China, Poland and Russia. During the quarter 524,468 tons were laid down, 693,627 tons were launched, 556,057 tons were completed and 50,751 tons suspended. Oil tankers over 1000 tons building abroad amounted to eighty-one ships of 781,450 tons, which was 82,885 tons less than in September last and represented 28·2 per cent of the total tonnage. World tonnage under construction totalled 1169 steamers and motorships of 4,818,753 tons gross, a decrease of 20,392 tons on the previous quarter; 42·8 per cent of the total was being built in Great Britain and Northern Ireland. World construction of oil tankers at 178 ships of 1,927,814 tons represented 40 per cent of the total tonnage and was a decrease of 46,861 tons since the end of September. At the end of December 3,027,202 tons or 62·8 per cent of the world tonnage was under the inspection of Lloyd's Register of Shipping; of this total 1,881,638 tons were under construction in Great Britain and Ireland, and the remainder, 1,145,564 tons, abroad.

Water Supply and Sanitation in 1950

THE water supply undertakings of a number of the larger cities of the British Isles were engaged in 1950 on extensive constructional works. Nothing need be said in this review of the largest of these undertakings, the Metropolitan Water Board, the work of which in 1950 will be described in a subsequent issue, except to mention briefly that a new method of construction was tried out for the tunnel for the large raw water main which will be laid from Hampton to Chingford. Interesting tunnelling work was also in progress in 1950, under the direction of the Manchester Corporation Waterworks, as part of the construction of the Haweswater aqueduct.

During the year work on the Bowland Forest tunnel continued, and a start was made on the driving of the Haslingden and Walmersley tunnels. A contract was also let and preliminary work started on the remaining long tunnel on this aqueduct, the Marl Hill tunnel. All the tunnels will have a finished circular section 8ft. 6in. in diameter with a gradient of 1 in 3000. Temporary support is in general being given by rolled steel channel arches spaced at 4ft centres with corrugated bank bars as laggings. Where the ground conditions are particularly difficult support is being given by precast reinforced concrete segments.

The whole of the tunnels will be lined with concrete on completion of the driving. In the lengths supported by steel arches the minimum thickness of the concrete will be 14in, and in the sections supported by reinforced concrete segments there will be a minimum thickness of 6in of concrete inside the flanges of the reinforced concrete segments.

The Bowland Forest tunnel will be 18,000 yards long with the south portal about 40 miles from the terminal reservoir of the aqueduct at Heaton Park, Manchester. The contractors, the Cementation Company, Ltd., established a camp to house 250 men at Hindburn towards the north end of the tunnel and a camp of double that size at Ellerbeck, towards the south end of the tunnel. The contractors are generating all the power required for the works, and the waste heat is being used to heat the camps.

A shaft 90ft deep was sunk at Ellerbeck and one 265ft deep at Croasdale. An adit at Hindburn gives further access to the tunnel line and driving was taking place simultaneously on four faces; shales, grits and limestone were encountered.

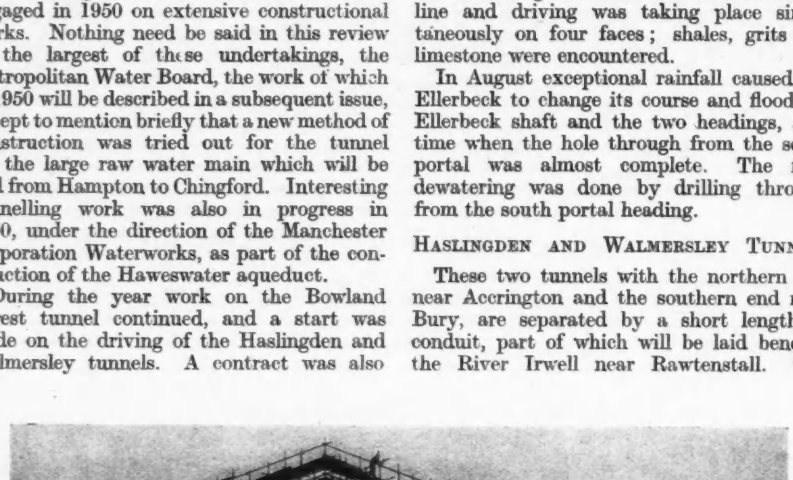
In August exceptional rainfall caused the Ellerbeck to change its course and flood the Ellerbeck shaft and the two headings, at a time when the hole through from the south portal was almost complete. The final dewatering was done by drilling through from the south portal heading.

Haslingden and Walmersley Tunnels

These two tunnels with the northern end near Accrington and the southern end near Bury, are separated by a short length of conduit, part of which will be laid beneath the River Irwell near Rawtenstall. The total length of the two tunnels will be 20,000 yards.

Grits and shales are being encountered in the tunnel driving. About 800 yards will be through coal workings and a short section near the Irwell will be in glacial drift. Coal was purchased by the Corporation as support for a length of the Haslingden tunnel. Shafts were sunk at Brynbella (160ft deep) and at Shuttleworth (240ft deep), and a shaft 375ft deep is being sunk, at Rising Bridge. Some difficulty was experienced in this work from a considerable inflow of water at a depth of 150ft, which is being dealt with by the use of cast iron segments with grout behind for the shaft lining, in place of the normal concrete lining.

Driving is at present taking place on five faces and the provision of the shafts listed above will enable work to take place simultaneously on eight faces in the peak period of the contract. The contractors are Edward Nuttall, Sons and Co. (London), Ltd., who established a central depot with workshops and a camp for 400 men at Rawtenstall. This contract is being carried out on a "value-cost" with target basis.



Priesthill Water Tower, Glasgow

Works at Glasgow

The first stage of an extensive post-war programme of works of the Glasgow Corporation Water Department was inaugurated last April (see The Engineer, April 28, 1950, page 503). These works included the laying of a 36in diameter main (the east main) from the service reservoir at Milngavie to serve the eastern and south-eastern parts of the city, and various other projects including a pumping station of 20 m.g.d. capacity, and a covered service reservoir with a capacity of 6 m.g.

We illustrate herewith one of the three water towers built as part of this programme. The chief purpose of the towers is to make use of "surplus water" by night in the existing distribution system by storing it for use during the following day. The tower illustrated has a capacity of 510,000 gallons, and was designed by F. A. Macdonald and Partners.

One of the problems of the east main works was to form a new outlet for the main at the Milngavie reservoir. The existing outlets had been designed without provision for extension, and it was necessary to break into an existing straining well and construct a forebay. These works were carried out in hard rock, and the use of explosives was precluded owing to the proximity of the existing installations.

Two Impounding Schemes

Two works in Sussex, one of which was completed and one started in 1950, exemplify a new trend in water supply practice in that county. Both of these works involved the construction of impounding reservoirs. The Darwell reservoir, which is formed by an earthen embankment 62ft high and about 1800ft long, was opened last October, to supply Hastings with up to 3½ m.g.d. Work was started on the Weir Wood reservoir, for the Weir Wood Water Board, where an earth dam 41ft high and 1680ft long is under construction. A supply of 3 m.g.d. will be obtained from this reservoir, which forms part of the Weir Wood Water Board's supply scheme for Crawley New Town and several neighbouring rural water authorities.

A survey of Sussex water supplies carried out by the Ministry of Health in 1944 disclosed that underground sources of water were already being pumped in excess of capacity and that yields from wells were falling off. Therefore, in spite of the low rainfall, and of the fact that for purposes of water supply, only the winter rainfall yields an appreciable run-off, impounding schemes were adopted in these two instances. The Darwell scheme was built by direct labour by the Hastings Corporation Water Department and the consulting engineers for the Weir Wood scheme are Messrs. Herbert Lapworth Partners, and the contractors Richard Costain, Ltd.

The Daer Scheme

Permanent construction work on the main dam of the Daer scheme of the Lanarkshire Water (Additional Requirements) Joint Committee was in progress throughout the year. The waters of the River Daer were turned through the diversion tunnel, and some 350,000 cubic yards of consolidated embankment were in place by the end of the year. The upstream stone toe with watertight diaphragm was practically completed, and considerable progress was made with the cut-off trench, grouting, valve tower and diversion roads. The dam will be 135ft high and about ½ mile in length when completed. The permanent construction is being carried out by direct administration. Eventually, filtration plant will be installed to deal with 25 m.g.d. from the new reservoir.

Progress was also made with the laying of the first section of trunk mains consisting of approximately 17 miles of 44in diameter

bitumen-lined steel pipes with Johnson couplings. This work is being carried out by Hugh Leggat, Ltd. The laying of a further 23 miles of 26/21in diameter steel main is envisaged. The consulting engineers for the scheme are Messrs. Binnie Deacon and Gourley.

Sewerage and Sewage Disposal

Of the many sewerage and sewage disposal works in progress in 1950, one or two representative examples are briefly described in the following paragraphs. Some of these examples illustrate the tendency to replace a group of existing installations by a system of trunk sewers leading to a single large disposal works.

In London further progress was made during 1950 with the London County Council's scheme for the improvement of the sewage effluents from the outfalls at Beckton, E.6, and Crossness, S.E.2, into the River Thames. Construction of detritus pits at the Northern Outfall Works (Beckton), suspended during the war, was resumed in March, 1950, and construction, at an estimated cost of £1,311,000, of mechanically operated sedimentation tanks of an aggregate capacity of 20,000,000 gallons was commenced in October last. Work is proceeding on the design of a large diffused-air activated sludge plant at each outfall, and on the preliminary design of further extensions to the works, including sludge digestion plants to treat all the sludge produced. Housing schemes in Wimbledon and Hurlingham made it necessary to provide additional capacity to relieve the sewers in these localities in time of storm. Construction of 4279ft of 5ft 6in diameter sewer in Wandsworth was started in 1950, and 2042ft of 5ft 3in diameter sewer in Walham Green was about to begin.

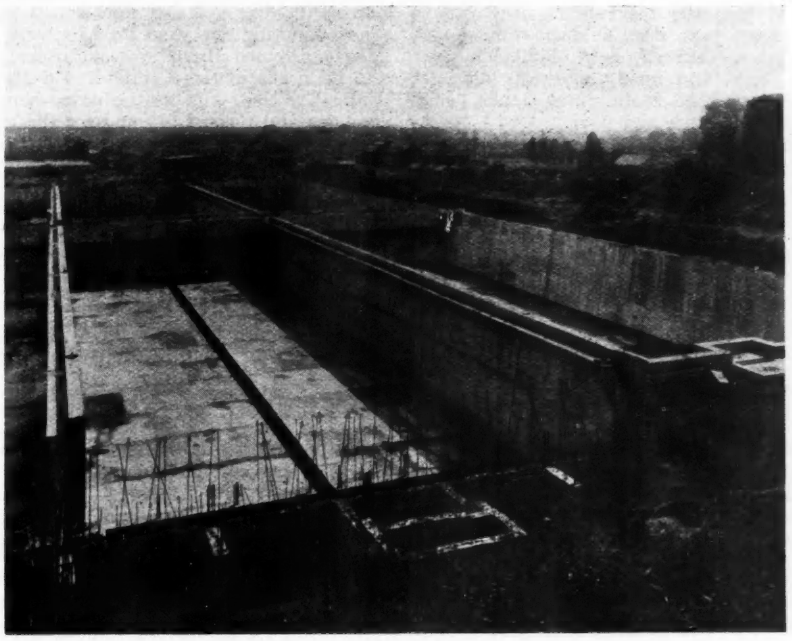
A Disposal Works Extension

An example of an extension to an existing disposal works, which was completed in 1939, is that of the reorganisation of the works of the Chigwell U.D.C. in Essex. These works were designed for a population of 33,000, with a dry-weather flow of 1 m.g.d. employing a straightforward single filtration with cold sludge digestion. The modifications which were started in the autumn of last year will introduce recirculation in the existing filters, thus bringing their capacity up to the required figure of 2 m.g.d. without the addition of more filters. The capacity of the sedimentation tanks will be doubled by installing an 80ft diameter clari-flocculator, and the humus tank capacity will ultimately be doubled by a duplication. Recirculation will be carried out by six axial-flow pumps, each with a capacity of 700 gallons per minute, and automatically controlled by the main recorder flume at the works inlet.

The sludge plant at the Chigwell works was originally designed for a smaller capacity than the rest of the works, the intention being to obtain information about the retention period required for the sludge. This plant has now been overloaded for some time, and it was intended that it should be converted to heated digestion and, if necessary, duplicated. The present proposals for heated digestion include provision for preheating the sludge in special preheating tanks. Experiments carried out by the manager at the works during the war showed that a considerable reduction in water content would be obtained by this preheating process, and it is hoped that the existing tanks with heated digestion, combined with the preheaters, will provide sufficient capacity for the new population. It is estimated that the extensions to the Chigwell sewage disposal works will be completed in about two years' time, progress up to the end of 1950 having included the construction of additional sludge-drying beds. The consulting engineers for this work are Messrs. Howard Humphreys and Sons, and the contractors W. and C. French, Ltd.

East Middlesex Main Drainage

Another work in the London area which was in progress in 1950 was the construction of eight storm-water tanks at Deephams sewage purification works at Edmonton. These tanks were being built for the Middlesex County Council, Deephams Works forming part of the East Middlesex main drainage scheme. Eventually a population of about a million will be served by Deephams Works, which will replace a number of small sewage works at present serving the drainage area, which is bounded by Tottenham, Barnet, Hatfield, Waltham Cross and Chingford. The construction of the storm-water tanks constituted the first stage of the new disposal works, and was almost completed by the end of the year, having been in progress since April, 1948.



Stormwater Tanks at Deephams Works

Each of the tanks is of reinforced concrete construction and is 190ft long, 60ft wide and 16ft deep. They are arranged in two rows with the effluent channels constructed between the rows. The intake ports are spaced along the outer edge of each tank, and there is a gentle fall along its length to the weir and draw-down pipes at the opposite end. The weir is at a higher level and feeds the upper effluent channel, and the draw-down pipes feed the lower one. There are two pairs of effluent channels running down the centre, each channel connected either to the weirs or the draw-down pipes of four of the tanks. There is a 2ft channel down the centre of each tank, falling towards the intake end, and leading to three sludge hoppers. A sludge drain runs under these hoppers along the intake side of each of the rows of four tanks for the removal of the sludge. The accompanying illustration shows two of the tanks, and the weir and draw-down pipes may be observed. The tanks on the other side of the effluent channels are visible in the background, the intake ports of which may also be seen. The total capacity of the eight tanks is about 9 million gallons and about 20,000 cubic yards of concrete, all placed by concrete pumps, were needed to build them. The consulting engineers for this work are Messrs. J. D. and D. M. Watson, and the contractors W. and C. French, Ltd.

Another interesting work in progress during the year for which Messrs. J. D. and D. M. Watson were the consulting engineers, and for which the contractors were H. C. Janes, Ltd., was the filtration of the effluent of the disposal works of the Borough of Luton. These disposal works are of modern construction, having been completed during the early part of the war, and serve a population of about 110,000 with a dry-weather flow of about 6 m.g.d. An effluent of Royal Commission Standard is produced which is discharged into the River Lee. One of the consequences of the air raid precautions of the last war was that various ornamental lakes formed along the River Lee just upstream of Luton, which were said to form conspicuous landmarks, were drained. Subsequently, when the war was over, deterioration of the bottoms of these lakes had formed fissures in the underlying chalk formation, which, in their turn, formed swallow holes which practically consumed the river flow.

Since a sewage effluent of normal standard requires a dilution of at least eight times its own volume of water to ensure the subsequent oxidation of the suspended solids remaining after treatment, it became necessary to introduce an additional stage to the normal treatment, since this volume of water was no longer available. It was decided to filter the effluent, thus removing virtually all the solid matter. Two types of filter were installed each to deal with a flow of 3 m.g.d., and each drawing from the outlet channels of the humus tanks of the works, and discharging into the river.

The first of these types consisted of three micro-strainers, supplied by Glenfield and Kennedy, Ltd., each of 1 m.g.d. capacity. The construction of this type of plant was outlined in our issue of September 9, 1949, page 290. The micro-strainers have now

been in operation for about four months. For the second half of the flow a set of six rapid gravity filter units were under construction during the year, and it is expected that they will be in operation very soon. Each of the filters is 21ft by 10ft, and is designed for a flow of 100 gallons per square foot per hour. The depth of the filter medium is 2ft, except in one case where the behaviour of a filter with a depth of 3ft 6in is being observed. The filters are fully automatic, except for periodical cleaning.

A Disposal Works in Hampshire

A project involving a modern sewage disposal works and the construction of trunk sewers, so that six existing sewage works will eventually be superseded, was started last year for the U.D.C. of Havant and Waterloo in Hampshire. The new works will cater for a population of 50,000 with an extension to 100,000, the dry-weather flow being 1·5 m.g.d., and there being allowance for treatment of six times that quantity. The raw sewage will first pass through screens and grit channels, with arrangements for washing the grit and screenings so that all organic matter will be disintegrated and passed into the main flow. The sewage will next pass into sedimentation tanks, and then through eight 100ft diameter filter beds, and finally into 65ft diameter humus tanks. Storm-water tanks, each 65ft in diameter and equipped with mechanical scrapers, will also be provided.

Sludge will be digested in two stages, with primary heated tanks and cold secondary tanks fitted with gas holders. The sludge will be dried on open beds with mechanical conveyors of special design for sludge removal. The sludge gas will be burned in dual-fuel engines which will drive generators and thus provide sufficient power for the works to be self-supporting. Both recirculation and alternating double filtration systems will be employed, and the sludge pumps, wash-out pumps and recirculation pumps with variable speed control will be in the power-house. There will also be an electrical recording system in the power-house, where the main flow and distribution through the works will be registered on a central panel.

Effluent will normally be discharged into the sea, and storm water given land treatment. During high spring tides, however, an automatic change-over will occur so that effluent which would be tide-locked will be discharged over the land and the storm water, if any, which would be at a higher level, discharged to the sea. One section of the trunk sewer is being constructed in tunnel, approximately 85ft below the London to Portsmouth road. The entire sewage of the area will be delivered to the works through three 24in diameter cast iron siphon pipes. The consulting engineers for this work are Messrs. Howard Humphreys and Sons, and the main contractors Campbell and McGill, Ltd. The contractor for the power-house is Trollope and Colls, Ltd., and for the trunk sewers A. Streeter and Co., Ltd. It is estimated that the first stage of the scheme will be completed early in 1952.

The Selection of Industrial Radiographers

By V. E. PULLIN, C.B.E.

RADIOGRAPHIC methods of investigation and inspection have now become an integral part of engineering and allied practice. Their everyday use has now spread from the large foundries and engineering works to smaller firms throughout the world. The recent availability of radioactive isotopes in a complementary capacity to X-rays is rapidly extending the industrial use of radiography. This state of affairs emphasises the vital need for trained radiographers in industry. This particular requirement virtually creates a new profession, demanding, as it does, specialised technical experience, together with other essential qualities.

What kind of a man should be chosen for training in this field? And what kind of a training should he receive?

These are questions that have perplexed experts for a considerable time and they are by no means yet satisfactorily answered. First of all, it is necessary to consider what are the functions of an industrial radiographer.

Radiography is used in the sphere of engineering in what may be regarded as a three-fold capacity. Maybe its paramount value is to be found when it is employed in a foundry and used in close association with those responsible for designing and producing castings. Early radiography will give to the founder vital information, which he can obtain in no other way. It will enable him to modify his practice at an economical stage and to proceed, with a far greater confidence, to produce sound structures than would be possible without the precise knowledge of defective initial effort that can be supplied by careful radiography and its skilful interpretation.

Another vitally important function of radiography in this sphere is that concerned with inspection. It has become the general custom to stipulate radiographic examination for all important engineering structures, such as castings, fabricated structures, high pressure welds, and so on. It is in these spheres of inspection that X-rays are probably more widely used and relied upon than in any other. At the same time, the diversity of work demanded calls for wide experience and expert technical skill on the part of the radiographer.

It is modern practice to demand 100 per cent precision radiography in the inspection of Grade I welding and in this work the highest radiographic skill is called for because complete reliance is placed upon radiographic inspection. All vital aeroplane castings are 100 per cent X-rayed. Oil refinery apparatus and important pipe line joints are also subject to this form of inspection. Important castings are examined by radiography in all stressed areas, and wherever the foundry expert considers that there may be a possibility of flaw development.

Another very valuable application of radiography (particularly by X-rays) has been shown to be their use in the training and periodic testing of high-grade welders. The work performed by these individuals is periodically X-rayed and the radiographs shown and explained to the men concerned. A sympathetic and skilful use of this method of training and checking the work of welders, has proved to be, in most cases, very popular with the men themselves. They are generally found to take a great interest in radiographic shadows and their interpretation, and they realise quickly and appreciatively the small familiar defects that give rise to the radiographic indications they see. Certainly in many cases within the writer's knowledge, the general improvement in the quality of welding has been a marked tribute to the value of these X-ray demonstrations. It is to be emphasised that the successful use of the scheme depends very largely upon the skill and tact of the radiographer.

The third general use of X-rays in engineering is mainly concerned with *ad hoc* consultative work. This is a progressively important and very wide field. Doubtful structures, new designs, and a variety of other problems incidental to daily practice are increasingly submitted to radiographic investigation as a routine procedure.

All sources of X-rays and gamma-rays are potentially dangerous to health and, while it is perfectly true that this danger may be eliminated by the use of appropriate and well understood precautions, the observance of these precautions both in the manipulation and radiographic use of all radiographic agents, involves a big subject, demanding trained and specialised instruction, experience and integrity in its practice. The safety of personnel and the proper use of apparatus is, in the end, the responsibility of the radiographer. It is true that regulations may be laid down, exhibited and circulated; but the observance of these regulations remains the personal responsibility of the individual in charge of the work.

From this rough outline it will be appreciated that the responsibility attached to the work of the radiographer in charge is of no mean order.

What type of man, then, is the best to choose to undergo training in industrial radiography?

It is manifestly impossible that any training organisation or course could comprehend the varied demands that will be made on the skill of the radiographer. It may be best, therefore, to contemplate a course of training which shall embrace all the necessary fundamentals of the general subject—a course of training that will enable the student to understand thoroughly the capabilities and (what is more important) the limitations of the various instruments and apparatus which will be available to him in his work. He must be able to apply at short notice the best possible conditions to enable the most to be got out of his art in any particular problem with which he may be faced, however difficult and out-of-the-ordinary it may be. It must be remembered that in industrial radiography the operator will have the choice of using various X-ray equipments varying in voltage from, say, 80,000 or 90,000 to 2 million volts. He will have radium, radon and radioactive isotopes at his disposal, which yield gamma radiation of various energies, and there will be various sizes of source. These isotopes will also be available to him in various concentrations. In addition to these prime sources of penetrating radiation, he will have at his disposal a large variety of photographic materials, sensitive films, intensifying screens, processing materials and so on, each of which will have different properties, particularly adapted to special conditions. It will be within his province to choose the best combination of these variables for any given problem. If he, through ignorance or carelessness, makes a wrong choice, then the

radiographic result may be entirely valueless.

It is thus easy to appreciate from a cursory glance at this subject that the fundamental training required in a radiographer must be comprehensive and, above all, it must be thorough.

In addition to the foregoing, the radiographer will be required to have an expert knowledge of the principles of radiographic interpretation. He will have to learn and be able to use, geometrical principles with great facility. The subject of industrial radiography resolves itself very largely into problems in geometry, if interpretation is to be reliable and accurate. The radiographer will be required to reconstruct the shape, position and dimensions of flaws from the shadows they project from any particular direction. He will have to assess the sensitivity of his results and express the whole of this picture in engineering terms.

It has been tacitly, though very generally, accepted that the function of the radiographer is to obtain a reliable radiograph and interpret in engineering terms the shadows therein. It has not been regarded as his responsibility to assess the mechanical or engineering significance of these radiographic flaws with regard to any particular structure, that being the province of the surveyor, inspector or other appropriate authority. The radiographer is merely required to interpret his pictures and to guarantee their reliability. If, however, he is to interpret radiographs clearly and intelligibly, he must obviously be able not only to understand without any doubt the meaning of the shadows that he interprets, but he must also be able to write a clear and lucid report for the benefit of those who have no knowledge of radiographic indications, and he must express radiographic indications in terms which can be understood by such people.

It is, in the view of the writer, very important that a radiographer doing any particular type of work shall not only have an expert technical knowledge of radiography as such, but it is imperative that he should have quite a wide understanding of the nature of the problems put forward for his investigation. For example, the casting radiographer should have a very good working knowledge of foundry practice and casting procedure generally. A radiographer doing work on constructional welding—for example, as met with in shipbuilding—must have a reasonable working knowledge of the structure he is asked to investigate. Furthermore, the radiographer engaged in Grade I welding radiography should know quite a lot about the technique of welding. Not only this, but he should be a man capable of working in close association with the experts whose work he is called upon to investigate.

Such then, very roughly, is the problem with which we are faced and which raises the question—what sort of man should we choose for this work?

It must be remembered that in large organisations quite a number of radiographers are employed and, as the method becomes more widely known and used, there is no doubt that these numbers will increase, both generally and in individual firms. It seems probable, therefore, that we must contemplate two distinct types of radiographer. It is, in the writer's view, essential that the radiographer in charge of important work should be a man of considerable scientific or technical standing. He should preferably be a man holding a degree in physics, metallurgy or engineering, and his radiographic training will then be superimposed on the most suitable background. With such a man in charge of general radiography in any particular organisation, it will probably be found sufficient to employ under him a number of people who might be termed "assistant radiographers," corresponding, it may be, to a laboratory assistant grading. Such people would carry out practical manipulative radiography according to the technical directions received from the radiographer in charge. They would not necessarily accept responsibility for the technique employed nor would they be responsible for interpretation and the writing of reports. These things will always remain the function of the highly trained radiographer. It may be objected that the employment of a radiographer of the calibre suggested in these notes would be economically outside the scope of a smaller firm, where the volume of radiography was not large. In such a case the difficulty might be met by training a member of the staff, who is engaged upon other work—say, a metallurgist, chemist, senior draughtsman, or suchlike—who could devote a small part of his time to the supervision of radiography, which would be carried out in all its practical details by a person less highly qualified. In some cases in this country, a communal system of radiography has been adopted, whereby a trained radiographer is attached to a mobile radiographic unit, which is at the disposal of three or four firms, who contribute to the upkeep of the section.

Whatever system may be adopted, it is in the writer's opinion of great importance that a man with a solid scientific background should be generally responsible for radiography. Certain large inspecting bodies, such as Lloyd's Register of Shipping, and the A.I.D., make a particular point of testing and approving radiographers who are employed on work under their ægis. Such a system has worked very well for a good many years.

It has been suggested above that it might be a good thing to legislate for a fundamental course in radiography embracing all the essentials of the subject. If the syllabus for such a course is carefully drawn up and sufficient time is allowed for adequate practical exercises, and assuming that the right type of student has been selected, it should unquestionably result in the production of adequately trained and reliable general industrial radiographers. They will have received instruction in all fundamental principles concerning the use of apparatus, production of reliable radiographs, comprehensive processing technique, and the general theory underlying interpretation.

The specialised practice that will be required in various industrial spheres is something which may be best learned when the radiographer undertakes the work that he is ultimately called upon to do. It may be that he will have to radiograph ferrous or non-ferrous castings, or Grade I boiler welds, constructional welding, or the checking of complicated assemblies. Whatever his work may be, he will have at his fingertips the basic principles of his subject and it will only be a question of ingenuity and experience before he becomes highly skilled in the particular demands of his practice.

There is no doubt that before long the need will be felt for extended facilities for teaching industrial radiography in this country. So far as the writer is aware, there is at least one school which has specialised in this subject for some years, and it may be that future demands will result in increasing the available facilities.

The point of pre-eminent importance, however, is to make quite certain that the right type of man is chosen for training in this increasingly important work, because unskilled radiography is so much waste of time and money. Either the work must be done skilfully and reliably or it is better not to do it at all.

An Autographic Method of Checking Micrometer Screws*

By F. H. ROLT, O.B.E., B.Sc., M.I.Mech.E., M.I.Prod.E.

THE usual method of checking the accuracy of the pitch of a micrometer head is illustrated in Fig. 1. The head is mounted in a "U"-shaped base opposite a sensitive indicator graduated to read to 0·0001in (0·0025mm) and capable of estimation to about one-tenth of that value. The basis of the test is a series of standard slip gauges, whose sizes cover the range of the micrometer screw, which is usually an inch (25mm). The micrometer head is set to read exactly zero by bringing the "0" line on its thimble precisely over the fiducial line on the barrel. (With an eyeglass this line-to-line setting can be repeated to a accuracy of 0·001in (0·025mm), which is equivalent to about 0·00002in (0·0005mm) in the axial position of the spindle.) A 0·1in slip gauge is inserted between the face of the micrometer head and the indicator, whilst the zero setting is being made; finally the indicator is also set to read exactly zero and locked in position. The slip gauge is changed to 0·2in and the reading of the indicator noted when the micrometer reading is reset to 0·1in precisely. This sequence of operations is repeated at 0·1in intervals throughout the range of the micrometer, using slip gauges of sizes 0·3in, 0·4in, up to 1·1in. The progressive errors in the readings of the micrometer at the points tested are given directly by the series of readings of the indicator. Periodic errors can be checked in the same way by taking readings at intervals of, say, 0·005in round one or more turns of the micrometer spindle.

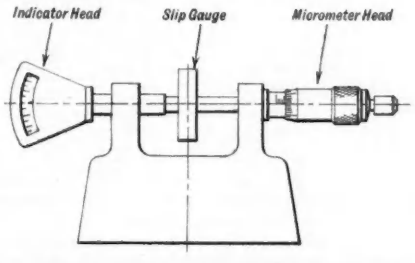


FIG. 1—SLIP GAUGE AND INDICATOR METHOD OF CHECKING MICROMETER HEAD

It will be appreciated that tests of this character, although quite accurate take a good deal of time and involve a fair amount of booking of readings. In addition, the number of points tested along the run of the

* Communication from the National Physical Laboratory, Teddington.

micrometer must of necessity be limited. If any rather local errors happened to be present they might well be missed. From all points of view therefore it would be an advantage if it were possible to obtain an autographic record of the errors of the micrometer continuously from one end of its travel to the other.

The method about to be described provides a means of obtaining such autographic

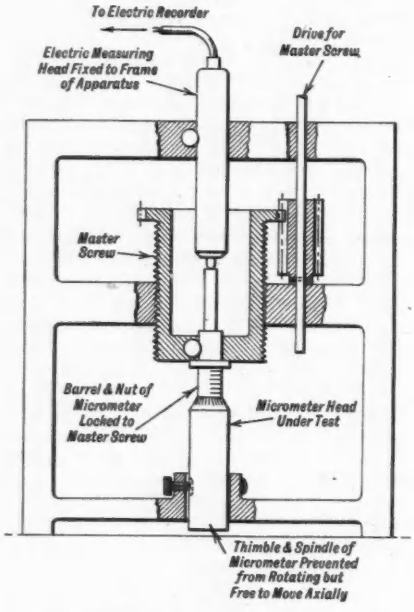

To Electric Recorder
Electric Measuring Head Fixed to Frame of Apparatus
Drive for Master Screw
Master Screw
Barrel & Nut of Micrometer Locked to Master Screw
Micrometer Head Under Test
Thimble & Spindle of Micrometer Prevented from Rotating but Free to Move Axially

FIG. 2—PRINCIPLE OF MICROMETER HEAD TEST APPARATUS

records. As will be seen, it compares the travel of the micrometer spindle continuously with that of a master screw and displays the difference as a trace on a moving strip of paper. It should be mentioned that the method is confined to checking the pitch of the micrometer screw in its nut. Unlike the slip gauge method, referred to above, its nut, the accuracy of the graduation being taken care of separately.

The principle underlying the method will be gathered from the schematic diagram shown in Fig. 2. The micrometer head is clamped to a master screw so that its barrel,

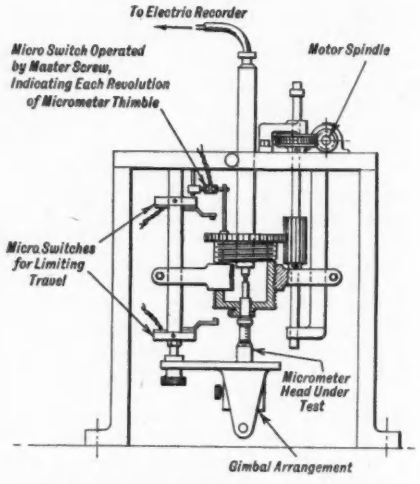

To Electric Recorder
Micro Switch Operated by Master Screw, Indicating Each Revolution of Micrometer Thimble
Motor Spindle
Micro Switches for Limiting Travel
Micrometer Head Under Test
Gimbal Arrangement

FIG. 4—GENERAL ARRANGEMENT FOR RECORDING OF ERRORS

and therefore its nut, will rotate integral with the screw. The thimble of the micrometer (to which the spindle is rigidly attached) is constrained from rotating by the frame, which supports the nut of the master screw as well as the measuring head. This constraint is such, however, that the thimble can, if necessary, still move axially by small amounts corresponding to any differences between the axial traverse of the master screw and that of the micrometer spindle. Those small differential movements of the spindle in the axial direction with respect to the frame will be continuously transmitted by the electric head to the recorder, where they will appear as a wavy line traced along the moving paper strip.

A general arrangement of the apparatus

from rotating by constraining it quite rigidly in a horizontal plane, whilst still allowing it to "float" vertically, spurious periodic errors were recorded on the chart. These were traced to slight eccentricities between the common axis of rotation of the micrometer barrel and nut and the axis of the thimble. The gimbal arrangement eliminated that trouble by allowing the thimble

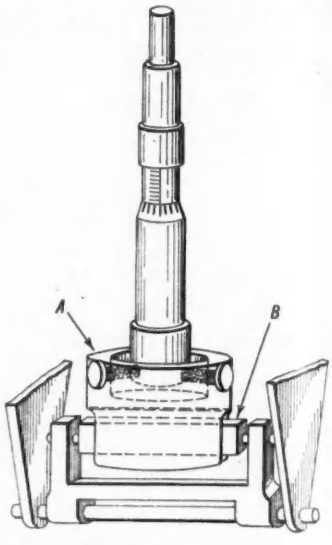


FIG. 5—GIMBAL ARRANGEMENT ALLOWING THIMBLE TO FLOAT

to "float" in a horizontal plane as well as vertically.

The arrangement used for obtaining this freedom will be understood from Fig. 5. The thimble is attached to a forked block *A*, which embraces a well-fitting bar *B*, rotatable about two parallel horizontal axes, one along its own longitudinal axis and the other directly below it. Any horizontal displacements of the micrometer spindle at right-angles to the plane of the paper are accommodated by slight rotations of the bar *B* about the two axes, and any horizontal displacements in the plane of the paper are permitted by the block *A* sliding along the bar *B*. Rotation of the spindle about its own axis is clearly prevented by this arrangement and yet the spindle is free to move vertically by a sliding movement of the fork on the block *A* over the bar *B*.

The steel master screw on this experi-

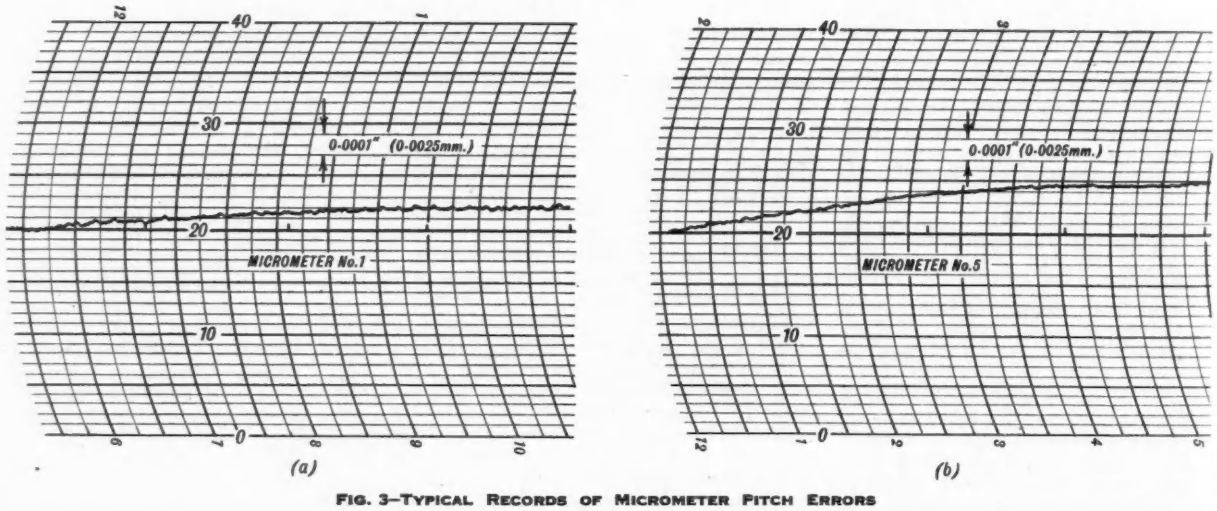


FIG. 3—TYPICAL RECORDS OF MICROMETER PITCH ERRORS

it takes no cognisance of any inherent errors in the graduations of the micrometer, for example, the spacing of the lines round the bevelled edge of the thimble or the parallelism of the longitudinal fiducial line with the axis of the screw. Nevertheless, the method may well appeal to manufacturers of micrometers as a convenient check on the accuracy of the micrometer screw and as constructed, is shown in Fig. 4. The micrometer head under test, the master screw with its driving gear, and the electrical head, will be easily recognised. The gimbal arrangement at the bottom for preventing the rotation of the micrometer thimble calls for some explanation. It was found from preliminary tests on some micrometer heads that, if the thimble was prevented

mental apparatus was 2½in (63·5mm) diameter and 2⅞in (73·0mm) long, and was thread ground. The nut was of bronze and was tapped with a ground thread tap. No special effort was made to obtain perfection of pitch in the master screw and nut but it would, of course, need attention before the apparatus could be put into regular use. The pitch could be rectified by lapping, supplemented possibly by the fitting of a corrector bar designed to give slight rotations to the nut to compensate for any residual errors.

For experimental purposes the apparatus was used with six new micrometer heads. Typical diagrams of the records obtained from them are shown in Fig. 3. The full length of each diagram represents the one-inch travel of the heads and the vertical scale of differences between the travel of the micrometer spindle and that of the master screw of the apparatus is marked on the records. As mentioned above, the pitch of the master screw itself was not exact, so that those records must not be taken as representative of the real errors of the two micrometer heads concerned. They do indicate, however, that the two heads differed by rather more than 0·0001in (0·0025mm) overall.

As a check on this, the two heads were calibrated at intervals of 0·2in (5mm) by the slip gauge method referred to earlier on. The results are shown in Fig. 6 to the same scale as in Fig. 3. It will be seen that the difference of 0·0001in is substantiated.

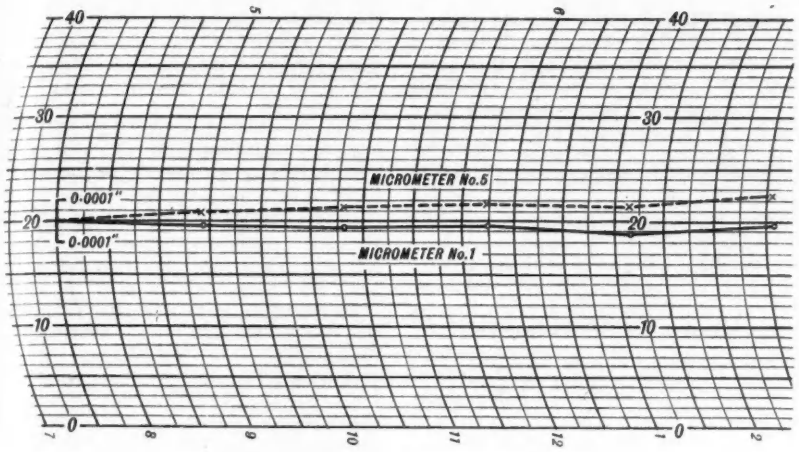


FIG. 6—CALIBRATION BY SLIP GAUGE METHOD

ACKNOWLEDGMENTS

The details of the design of this experimental apparatus were carried out by Mr. W. Atkins; it was constructed by Mr. J. White and the experimental work, including some modifications of details, was made by Mr. P. Harrison. The work described was carried out as part of the research programme of the National Physical Laboratory and this article is published by permission of the Director.

Metallurgical Developments in 1950

THE following remarks refer to the development of metallurgical materials only, not to that of plant or processes. There is necessarily a long time between the discovery of a new product and its large-scale application, and this interval may be regarded as the period of development. A year is a short time for establishing the utility of a new material, and therefore the developments of 1950 have their roots in the laboratory investigations and small-scale trials of previous years. Hence, some products to be mentioned are not new in the sense that they were not heard of before; but they rank as developments of 1950 because of the advances made in improving their quality, increasing their availability or extending their uses during that period. For information about such advances one would naturally turn to the various metallurgical research associations (all of which are also concerned with development) or to the development associations dealing with specific metals. A brief general account, such as is given here, can only touch the fringe of the activities of these bodies, the corresponding industrial organisations and the industries they represent.

COPPER AND COPPER ALLOYS

The Copper Development Association, in accordance with its usual practice, will doubtless issue as a C.D.A. publication the survey of technical progress in this field during 1950, comprised in the article "Copper and Copper Alloys," by Dr. E. Voce, appearing in the issue of *Metallurgia* for December, 1950. These annual surveys are very valuable in giving detailed references to the literature.

As usual, the development of any particular material may be followed through several years. For example, the use of manganese in copper alloys, though by no means a new development, has continued to extend for many years past. The straight copper-manganese alloys, whose properties can only be modified by cold work and annealing, have given place to alloys of copper and manganese with a third element, which in many cases respond to heat-treatment. Examples are a range of high-manganese brasses, containing copper 55 to 72, zinc 10 to 24, and manganese 8 to 31 per cent, with small additions of silicon and aluminium, introduced by the New Jersey Zinc Company, and the heat-treatable copper-nickel-manganese alloys developed by Dean and his collaborators in America and by I.C.I. (Metals), Ltd., in this country. The main line of development in copper alloys lies in the exploitation of alloy systems which show precipitation hardening, and the number of heat-treatable copper alloys increases every year. A recent example is the so-called Phosnic Bronze, in which nickel and phosphorus are added to copper in the proportion required to form nickel phosphide, giving an alloy of relatively high electrical conductivity in the precipitation-hardened condition. The older types of copper alloys have found wider applications. Thus, the high-strength aluminium-iron-nickel bronzes have been extensively used as gravity die-castings, and one such alloy of carefully controlled composition has been developed for use in gas turbines, particularly as compressor blades and heat-exchanger tubes. Beryllium-copper also, in spite of its high cost, continues to increase in popularity for springs, diaphragms, &c., in the manufacture of instruments.

NICKEL AND NICKEL ALLOYS

An up-to-date summary of the properties of "Nickel and its Alloys" has been issued as a seventy-two page circular (No. 485) by the U.S. National Bureau of Standards. "The Engineering Properties of Monel, Nickel and Inconel" is the subject of a brochure by Henry Wiggin and Co., Ltd., and *The Nickel Bulletin* provides all current information about research and development affecting nickel and nickel alloys. New uses for nickel-clad steel in the beet-sugar industry, and for Monel metal as a sheathing for steel exposed to sea water, are being found on account of their corrosion-resisting properties. Alloys long known in the laboratory have reached the stage of large-scale production; for example, the nickel-molybdenum base alloys, sometimes containing chromium, possessing exceptionally high resistance to attack by acids. Langalloy "4R" and "5R" (made by Langley Alloys, Ltd.) are of this type, as also are the "Corrosist" alloys; experience with these alloys in industry has been described during the year. The standard Inconel alloy (containing 14 to 18 per cent chromium and 7 to 9 per cent iron) continues to find applications in the chemical and food industries, and in domestic heating apparatus; and compositions derived from it, such as Inconel X, containing in addition titanium, aluminium and niobium, have been found suitable for springs which are required to withstand high temperatures, and also for gas turbine rotor wheels and sheet metal parts of jet engines and rocket motor assemblies.

Another series of nickel-base alloys for service at high temperatures was recently described. They contain nickel, aluminium and molybdenum, the Ni : Al ratio varying from 12 : 1 to 8 : 1, and the molybdenum content from 12 to 28 per cent. The data accumulated in tests made at temperatures up to 815 deg. Cent. justify the opinion that these alloys will be useful at elevated temperatures. The high-temperature applications of nickel alloys are dealt with later, under the heading "Heat-Resisting Steels and Alloys."

Nickel-rich alloys have long been pre-eminent with regard to the control which may be exercised, by proper choice of composition and treatment, on temperature changes in dimensions or in such physical properties as elastic modulus. Recent examples, the result of some years' research and development, are the "Nilo" series of low-expansion alloys made by Henry Wiggin and Co.,

Ltd., including the nickel-cobalt-iron alloy intended for making vacuum-tight glass-to-metal seals.

Other Non-Ferrous Alloys

Light Alloys.—Several complex aluminium alloys have been described or were the subject of patents during 1950. Attempts to obtain a useful alloy with lower alloy content and not so strong as the standard high-strength aluminium-magnesium-zinc alloys, but at the same time presenting fewer difficulties in fabrication and heat-treatment, led to the development of "Superalumag T 35," containing zinc 2·75 to 3·75 and magnesium 1·5 to 1·75 per cent, with small amounts of manganese and chromium, and having a tensile strength of 22 tons per square inch, and an elongation of 16 to 18 per cent. Mention may also be made of "Almag 35," a high-strength casting alloy for which heat-treatment is not required. It is essentially an aluminium-magnesium alloy (magnesium 6·5 to 7·5 per cent) based on high-purity aluminium, and is notable for its mirror-like finish when polished and its resistance to corrosion.

There is nothing very novel to report about magnesium alloys. Interest has centred round the already known effects of additions of zirconium and of cerium in endeavours to improve casting properties and strength at raised temperatures; and the development of magnesium-lithium alloys, with the addition of a third element to promote precipitation hardening, was pursued during the year in the hope of ultimately obtaining a commercially useful alloy of lower density than magnesium and with a strength-weight ratio equal to that of the strongest aluminium alloys.

Tin Alloys.—Considerable extension of the laboratories and equipment of the Tin Research Institute took place during the year, and some further developments in tin alloys are foreshadowed by the researches in progress there. The aluminium-tin system has been examined with results communicated to the Institute of Metals in 1949, and there is reason to believe that the type of alloy containing 6 per cent of tin, that has been used with some success for bearings, can be improved by increasing the tin content. Alloys containing up to 30 per cent of tin have been made satisfactorily and information has been obtained of the factors that affect the favourable state of distribution of the tin. The influence of the distribution of the tin on the mechanical properties of the alloys, particularly on their fatigue resistance and anti-friction characteristics, is being fully investigated.

A new process for the deposition of bright tin-nickel alloy plate was invented and was operated on a laboratory scale. It was the subject of a communication to the Electro-depositors' Technical Society in December, 1950. The plate contains approximately 65 per cent of tin and is an intermetallic compound in structure. It is characterised by a pleasing appearance and an extremely high resistance to atmospheric tarnishing.

The Rarer Metals

Examples of development work which is proceeding rapidly, but did not yet reach the stage of commercial application in 1950, are to be found in the efforts being made to prepare the rarer metals in a pure and ductile condition and in sufficient quantity, either for direct use or to form the basis of useful alloys. Of these, the outstanding example is titanium. A very large amount of information is now available about titanium alloys, and potential uses of both the metal and its alloys are being sought. Considerable advance has been made in the production of ductile molybdenum by arc-melting and casting methods. On a much smaller scale ductile zirconium and ductile vanadium are being produced, mainly in America while gallium is another rare metal that is now available in small quantities which, however, exceed the requirements of its present applications.

Alloy Steels

Two types of precipitation-hardening stainless steels were further developed by the Armco Steel Corporation, one (Armco 17–4 PH) containing chromium 17, nickel 4 and copper 4 per cent, and the other (Armco 17–7 PH) chromium 17, nickel 7 and aluminium 1 per cent. Advantages are claimed both in mechanical and in corrosion resisting properties. The properties of a low-carbon stainless composition (designated Carpenter No. 10, and containing chromium 16, nickel 18 per cent), said to be specially suitable for cold-headed or upset parts, have been described. The steel is resistant to a wide variety of organic chemicals and food-stuffs. Reports made to the Electric Process Sub-Committee of the British Iron and Steel Research Association were published, describing the use of oxygen in the production of low-carbon stainless and other alloy steels. This, however, is a matter of technique of production, not of a new product, as stainless steels with a maximum of 0·03 per cent of carbon have been made by other manufacturing methods for a considerable time.

In work on the economy of alloy additions to high-tensile heat-treated steels, the tendency is to retain molybdenum and increase manganese content in replacement of chromium and partial replacement of nickel (as, for example, in the American "Hy-Tuf" composition), but the year was not marked by any very novel practical development in this field, nor in the production of any new high-tensile weldable structural steel, though Bardgett and Reeve in 1949 showed that boron may in some compositions have a favourable hardening effect on the hot-rolled or normalised steel.

During 1950 there was a considerable extension of interest in the use of lead-bearing steels. Mechanical properties are not, in general, adversely affected to any serious extent, though the ratio of fatigue strength to tensile strength may be reduced as tensile strength increases. This fact and the improvement in machinability were demonstrated in a paper by Woolman and Jacques in the *Journal* of the Iron and Steel Institute (July, 1950), and extensive information about the effect of lead additions to alloy steels is presented in the brochure of Samuel Fox and Co., Ltd., "Some Notes on Alloy Steels Containing Lead." As indicated in this publication, improved machinability of the lead-treated alloy steels shows to greatest advantage in repetition work, and the adoption and development of the use of such qualities have been greatest among industries employing mass-production methods.

Heat-Resisting Steels and Alloys

During 1950 the British Iron and Steel Research Association has been concerned with the development of steels to resist high operating temperatures in steam plants, including ferritic steels for superheater tubes. Ferritic steels of the chromium-molybdenum and chromium-molybdenum-vanadium type are available for temperatures up to 550 deg. Cent., and some varieties with a high resistance to deformation by creep are used for gas turbine discs. The advantages of ferritic steels for this purpose are that they have a higher yield strength than austenitic steels, lower coefficient of expansion, higher thermal conductivity, better machinability and lower cost, so that research continues with the object of increasing their range of temperature-resistance. During 1950, large-scale production was commenced of turbine discs in Jessop H 46 steel, a 0·16 per cent carbon, 12 per cent chromium steel with additions of carbide-forming elements to increase its resistance to deformation by creep at temperatures of the order of 600 deg. to 650 deg. Cent. Austenitic steels (such as HR Crown Max., R 22, G 18 B, &c.) must be used to withstand higher temperatures, as in inlet nozzles and rotor blades. The low yield strength of austenitic steels is a disadvantage, especially when they are used for turbine discs in which stresses are high causing deformation at the hub, and during the last two years nearly all the discs made in G 18 B have been subjected to a "warm-working" operation, which raises the 0·1 per cent yield strength from about 18 to about 25 tons per square inch. As a turbine blade material, G 19 was announced during the year. This is a development of G 18 B with similar creep strength, but with much improved scale resistance at temperatures above 800 deg. Cent. It has been used for both investment-cast and forged gas turbine muzzle vanes, as well as in sheet and tube form. The high-cobalt alloy, Jessop G 32 (Co 45, Cr 19, Ni 12, Mo 2, Nb 1·2 and V 2·8 per cent) with high creep strength at 850 deg. Cent., constitutes an important advance in materials for turbine rotor blades, in which form it has undergone engine tests during 1950. It has also been produced as tubes and sheets. A similar alloy, G 34, with composition adjusted to give the best casting properties, was introduced during 1950. It has been developed primarily for the investment casting of parts such as turbine nozzle vanes.

Still of outstanding importance are the well-known series of Nimonic alloys, developed over a period of ten years. They are now carefully graded to meet special combinations of circumstances. They consist of the numbered series, required to meet specified creep resistance, the one-letter series of wrought alloys of similar composition, but not creep tested, and the two-letter series also of similar composition, but supplied in a form suitable for remelting, and thus for the production of castings. A noteworthy stage was reached in the development of these alloys by the disclosure, during 1950, of information about the physical and mechanical properties of Nimonic 90. The increased creep strength available with Nimonic 90 is well shown by the fact that, for the same specified criterion of creep, at 750 deg. Cent., Nimonic 80 is required to withstand a stress of 17 tons per square inch and Nimonic 90 a stress of 19 tons per square inch. At 815 deg. and even at 870 deg. Cent., Nimonic 90 has high load-carrying capacity for long periods. Here, as always, the achievement was due to prolonged research and extensive trials, so that, on release of the available data about this new alloy, it is possible to record that it has been successfully used in the latest types of turbo-jet engines for a considerable period.

A Symposium on High-Temperature Steels and Alloys for Gas Turbines, organised by the Iron and Steel Institute, had unfortunately to be postponed until February, 1951, and the thirty-five or more papers expected to be presented on that occasion will give a comprehensive picture of the present position. Meanwhile, progress with the improvement of this class of material

is always ahead of the latest published information.

Magnetic Materials

In the report of a "Symposium of Papers on Ferromagnetic Materials" (November, 1949), published by the Institution of Electrical Engineers in April, 1950, metallurgical factors affecting magnetic properties were discussed. Two papers dealt with the electrical and magnetic properties of ferrite materials (MnZn and NiZn ferrites). Work on these has been going on in the Philips Research Laboratories for ten years, and one paper surveyed the possible applications of ferrites, including their use in transformers, magnetic amplifiers and various measuring instruments.

Developments have been steadily taking place in both high-permeability alloys and permanent magnet materials. Noteworthy among the latter are the niobium-containing permanent magnet alloys described by D. A. Oliver and D. Hadfield. The addition of niobium to anisotropic Alcomax II was found to nullify, in some degree, the detrimental effect of carbon on the magnetic properties, and to render the alloy less sensitive to variations in heat-treatment. Niobium additions up to 3·78 per cent were studied, but the peak properties were obtained with only 0·2 per cent niobium. Similarly, in anisotropic Hycomax I, 0·48 per cent niobium gave a slight increase in coercive force while the remanence was a little reduced, no improvement in energy being obtained. There was an increase in coercive force accompanying increase in niobium content, and alloys with higher niobium or tantalum are stated to be under study.

Actual compositions and treatments of the Alcomax and Alnico alloys did not apparently undergo any substantial change during 1950, but many practical applications were described in which the more powerful permanent magnets now available may, with advantage, replace electromagnets.

Cast Iron

The British Cast Iron Research Association continued its investigations on nodular graphite structures in cast iron. A comprehensive report by H. Morrogh on the subject was issued during the year. There are now three very similar methods of producing nodular graphite structures, with resulting ductility, in cast iron without the necessity of employing any heat-treatment. Two of these—the cerium and the magnesium methods—are being actively developed, the former by the Association and the latter both by the Association and by the Mond Nickel Company, largely on account of their interest in the nickel-magnesium alloy which is the best medium for the introduction of the magnesium addition. Not only have the properties of these irons been most extensively studied here, in America and on the Continent, but their value in numerous applications has been fully demonstrated. The engineering applications of cast irons in general have been furthered by the Association's work on "Fatigue Tests on Flake and Nodular Cast Irons" and on the "Properties of Various Cast Irons at Sub-Zero Temperatures," and also by publications emanating from the Mond Nickel Company and relating chiefly to the special alloy cast irons.

A good deal of activity last year centred round the Productivity Team which visited the U.S.A. and whose report was published in September, and in this connection the Association held several full-scale conferences. Another new activity during the year was the establishment of a small Operational Research Team for the purpose of visiting the foundries of member firms in order to assist in increasing their technical and productive efficiency.

Productive Efficiency

The comment contained in the last paragraph on the work of one particular research association is, in large measure, true of all metallurgical organisations in the country. The year 1950 was not notable for the announcement of any startlingly new development in metallurgical materials so much as for steady expansion of the use of materials whose properties were already understood. The practical value of many such materials was established, and their field of application widened to meet the ever more stringent requirements of engineers.

Safety Valve Discharge Capacity Tests

SAFETY valves were discussed as far back as 1855, but the valves of those days were weight operated, and it was not until 1875 that the Board of Trade allowed spring-operated safety valves to be used in this country. The development of these valves brought first the high-lift and later the full-lift safety valve. The calculated discharge capacity of these was limited by the constant C in the B.S. 759 : 1937 formula :—

$$A = \frac{E}{CP},$$

where

A = area in square inches of safety valve orifice,
E = maximum evaporation from boiler in pounds of steam per hour,
P = set pressure of safety valve in p.s.i. abs.,

and

C = a constant.

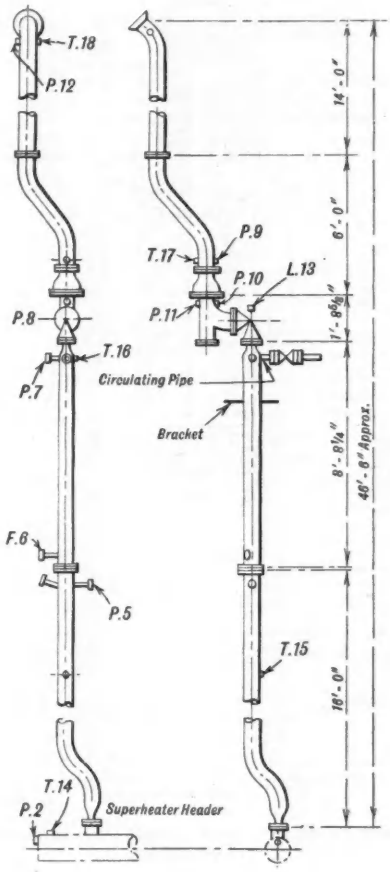
As the actual discharge capacity was greatly in excess of theoretical figures, it soon became clear that, by limiting C to 20 for full-lift valves fitted to water-tube boilers of an evaporation capacity greater than 10,000 lb of water per hour, the total discharge area of all safety valves fitted to a boiler would be greatly in excess of actual requirements. This not only meant that the number of openings in the shell or drum of the boiler could be reduced, but that, by fitting a smaller number of valves, maintenance costs would also be lowered. The publication of the revised B.S. 759 in 1950 takes care of these points, and states that higher constants than those permitted can now be used where approved capacity tests have been carried out.

In the United States all safety valves have to undergo a series of tests before they are accepted by the A.S.M.E. These tests are not recognised by the British insurance companies. It was therefore decided by Dewrance and Co., Ltd., in conjunction with the Associated Companies Technical Committee (A.C.T.C.) to test two types of valves in order to obtain actual discharge capacity figures, and to prove that a more satisfactory constant for the B.S. 759 formula could be used. The safety valves chosen were of the Dewrance Consolidated "Full-Lift" and "Maxiflow" types. It was also obvious that other useful information could be derived from such tests, particularly pressures and temperatures in the exhaust pipes.

Description of Test

The boiler on which these valves were tested was constructed by Babcock and Wilcox, Ltd., for firing with pulverised fuel. It has a rated capacity of 240,000 lb of steam per hour, and the pressure at the superheater outlet is 650 lb per square inch, at a temperature of 850 deg. Fah. The four existing drum safety valves are set at 750 lb to 760 lb per square inch, and the two superheater safety valves at 700 lb to 705 lb per square inch.

In the preparation of the test it was thought that the steam flow might easily be measured in the exhaust pipe, but this idea was discarded because of the high steam velocities which would be encountered there. A method was therefore adopted whereby the steam would be measured on the inlet side of the valve. The safety valve under test was one of the two on the superheater; but, to permit suitable measuring instruments to be utilised between the superheater and the valve, it was necessary to fit a length of straight pipe of such dimensions as would minimise the drop in pressure when the safety valve lifted, the diameter being large enough to slow down the steam speed to a suitable rate to give accurate readings on a flowmeter. The arrangement is shown in Fig. 1; it should be noted that the pipe leading into the safety valve was increased from 3½in bore to 7in bore, and reduced again prior to entering the valve. To steady the pipe and allow for expansion when the safety valve was blowing a special bracket to which rollers were fitted was used. The rollers were adjusted to



Readings Taken During Test

1. Time.
P.2. Superheater Header Pressure.
P.4A. Drum Pressure.
P.5. Pressure at Flowmeter Nozzle
F.6. Steam Flow at Flowmeter Nozzle (Recorded).
P.7. Safety Valve Inlet Pressure.
P.8. Pressure in Safety Valve Body.
P.9. Pressure after Slip Joint.
P.10. Pressure at Safety Valve Outlet (Inside Bend).
P.11. Pressure at Safety Valve Outlet (Outside Bend).
P.12. Escape Pipe Outlet Pressure.
L.13. Lift of Safety Valve.
T.15. Temperature at Flowmeter Nozzle.
T.16. Temperature at Safety Valve Inlet.
T.17. Temperature at Safety Valve Outlet.
T.18. Temperature at Escape Pipe Outlet.

Fig. 1—Test Arrangement for "Full Lift" and "Maxiflow" Superheater Valves

be free to rotate after the boiler and pipe-line had been heated, but before any blowing of the valve had taken place.

The steam flow was measured by the pressure drop across the flow nozzle in the 7in pipe, as shown at position *F*6, Fig. 1. The meter used was a commercial bellows-operated recorder, which was maintained and operated throughout the test by the suppliers. The chart of the recorder was geared to give one revolution per hour. The meter was designed for a maximum steam flow of 100,000 lb per hour at 680 lb per square inch and 800 deg. Fah. The values read have been corrected by the appropriate temperature factor, i.e.:—

$$\sqrt{v_a/v}$$

where

v_a = specific volume of steam at 680 p.s.i., 800 deg. Fah.,

v = specific volume of steam during test.

The meter was checked against a water head both before and after each test. The pressure

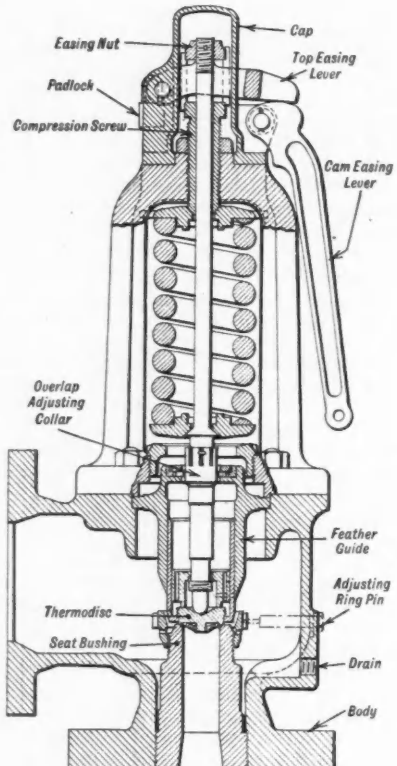


FIG. 2—"FULL LIFT" SAFETY VALVE WITH THERMODISC

gauges used were standard commercial gauges which were specially checked before and after each test on a deadweight test pump. The temperature measurements were carried out by "chromel alumel" thermocouples which extended into the steam space. The response to temperature changes was very quick and the thermocouple wires were specially checked for the purpose of the test. The readings recorded at *T*15, 16 and 17 on Fig. 1 were read on a potentiometer and the instrument at *T*18 was a "Micromax" recorder giving one-minute readings. The lift of the valve was recorded on a specially constructed indicator, attached to the valve head and driven by synchronous electric motor which was geared to rotate the drum carrying the indicator paper at the rate of 1in in five minutes.

A steam circulating valve was fitted just under the safety valve to bring the pipe-line up to temperature before the valve was blown. This also prevented any accumulation of water in the pipe and, incidentally, in the exhaust, as all drains were coupled together, and a certain amount of the circulating steam was allowed to pass through the exhaust pipe to atmosphere. Before being fitted to the extended pipe the safety valve was floated at 650 lb per square inch and adjusted for the correct blowdown.

The boiler was brought to pressure at approximately 500 lb to 550 lb per square inch, when the aforementioned roller brackets were adjusted. At the time of testing one p.f. mill was used until 600 lb per square inch was reached, then the other mill was brought into action. At 625 lb per square inch the circulating valve was closed and, from the moment of blowing, readings were taken at all check points (Fig. 1) at quarter-minute intervals, the time being indicated by a light signal from a central control position. The possibility that the safety valve might "chatter," due to the pressure drop in the extended pipe, was considered, but in practice it was found that the valve lifted and closed cleanly without vibration.

"FULL-LIFT" VALVE TEST

Before giving the results of the test a description of the safety valve will be necessary. Fig. 2 shows a typical arrangement of the Dewrance "Consolidated Full-Lift" safety valve. This valve has a special seat bushing, and it will be observed that the joint is made between the seat bushing and the boiler pad.

When a safety valve reseats after lifting a small amount of leakage momentarily occurs

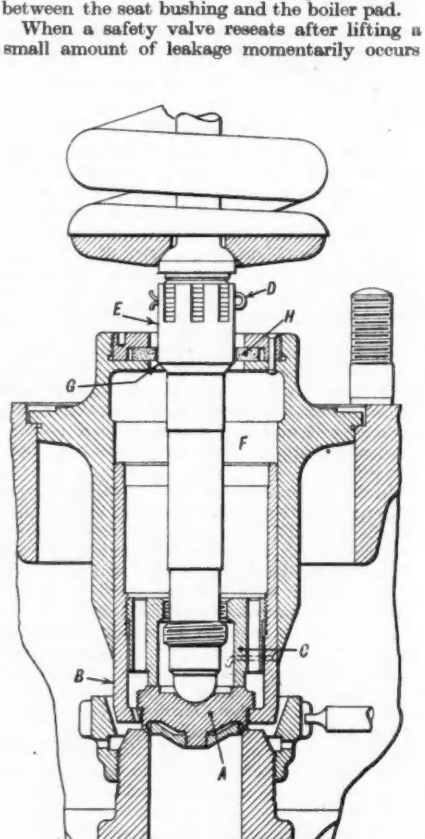
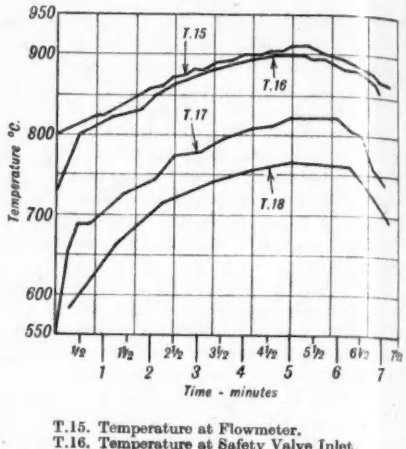


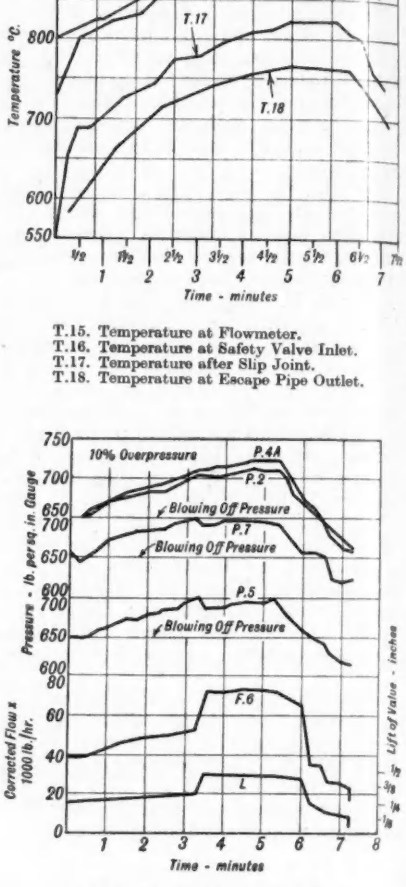
FIG. 3—DETAIL OF "FULL LIFT" SAFETY VALVE WITH THERMODISC

between the seat and the disc before the valve finally seals off and becomes tight. This leakage (actually an expansion of gas across an orifice) sets up a temperature differential between the point of leakage and the remainder of the circumferential seat contact. These differences in temperature create severe thermal stresses, resulting in slight distortion of the seat contact surfaces, which may further aggravate the leakage. In the lower pressure ranges this may not be serious, but tests carried out at 1200 lb per square inch showed temperature differences of 300 deg. Fah. and higher around the valve lid and seat contact circumference. In addition, the portion of the valve lid inside the seat contact surface is exposed to full operating temperatures, whereas the guiding portion of the valve lid remains comparatively cool.

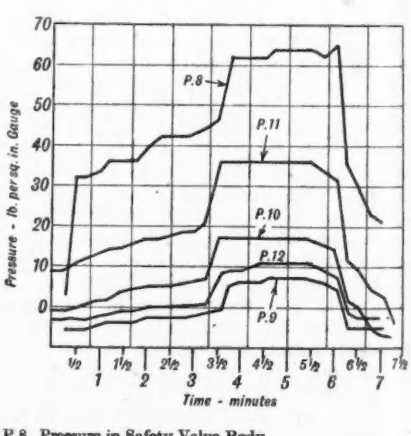
Therefore the solution to the leakage problem



T.15. Temperature at Flowmeter.
T.16. Temperature at Safety Valve Inlet.
T.17. Temperature after Slip Joint.
T.18. Temperature at Escape Pipe Outlet.



P.2. Superheater Header Pressure.
P.4A. Drum Pressure.
P.5. Pressure at Flowmeter Nozzle.
P.7. Pressure at Safety Valve Inlet.
F.6. Flow of Steam.
L. Lift of Valve.



P.8. Pressure in Safety Valve Body.
P.9. Pressure after Slip Joint.
P.10. Pressure at Safety Valve Outlet (Inside Bend).
P.11. Pressure at Safety Valve Outlet (Outside Bend).
P.12. Pressure at Escape Pipe Outlet.

FIGS. 4, 5 AND 6—3IN "FIG. 7009 FULL LIFT" SAFETY VALVE TEST

was found in a design which would accomplish the following three objects :—

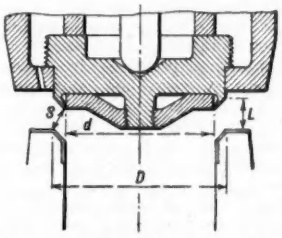
First, the valve lid should be sufficiently flexible to accommodate any distortion of the

sealing lips due to temperature differential around the actual seating surfaces. Secondly, the seat portion should be separated from the large mass of the valve body. Thirdly, there should be a positive closing action, which would result in a clean sharp cut-off without simmer.

The new valve, which was tested at Meaford, is in service on a number of installations for pressures up to 2700 lb per square inch, and the makers claim that it provides an improved standard of tightness.

Details of construction are shown in Fig. 3. The valve lid A is a separate and replaceable component permitting the use of the most suitable material. The tightness of this design is due to the shape of the valve lid element itself, which is recessed so that a thin lip is provided at the actual seating contact. This is flexible enough to compensate for any distortion due to temperature. The valve lid A is held in the valve lid holder B by a retaining nut C. Assembled in this manner, and with proper clearances, the element A is then free to expand and contract independently of the holder B, the temperature of which may be lower by several hundred degrees. Thermal stresses are thus reduced to a minimum.

Positive closing is obtained by a booster effect, which will be understood by further reference to Fig. 3. When the valve discharges steam escapes to the chamber F past the spindle overlap G, which takes up a position above the plate H. On closing, the spindle overlap G moves down below the opening in plate H and the momentary pressure build-up in the chamber F assists the downward move-



Area of Discharge = Area bounded by D, d and S, that is = Peripheral area of truncated cone of major diameter D, minor diameter d, slant height S (or vertical height L),

$$=\frac{\pi}{2}(D+d)\sqrt{L^2-L(D-d)+\frac{(D-d)^2}{2}}$$

FIG. 7—DISCHARGE AREA OF 3IN "FIG. 7009 FULL LIFT" SAFETY VALVE

ment of the valve head in the direction of the spring thrust, to assure positive closing of the valve.

Whenever maintenance work on the seat and valve lid is required for repairing the seating surfaces, the necessary adjustment of the spindle overlap is easily accomplished by removing split pin D, turning the sleeve E and replacing the pin. Spare valve lids can be installed quickly and the necessity for machine work is eliminated.

The results of the full-lift safety valve test are shown in Figs. 4, 5 and 6. The accompanying table shows the dimensions of the pipe and safety valve.

TABLE I.—*Dimensions of Pipe and Safety Valves*

Bore of pipe at flowmeter	7·445in
Bore of flowmeter nozzle	4·344in
Bore of pipe before slip joint ...	5in
Bore of pipe after slip joint ...	$6\frac{13}{16}$in
Bore through full-lift safety valve seat	2·501in
Spring of full-lift safety valve :	
Free length	$9^{1}/_{64}$in
Compression at load...	$^{31}/_{64}$in
Total number of coils	Seven
Inside diameter...	$2^{27}/_{32}$in
Wire diameter	$1^{5}/_{64}$in
Spring rate (tested by George Salter and Co., Ltd., Birmingham)	7280 lb per inch
Barometer on Tuesday, May 23rd, 1950, at 11.30 a.m.	29·78in
Temperature	64 deg. Fah.

Rewriting, the B.S. 759 formula for saturated steam is

$$C=\frac{E}{AP} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

For the purpose of this test E has been taken as the flow through the valve in pounds per hour.

For superheated steam,

$$A_s=A\sqrt{1+\frac{1\cdot5T_s}{1000}} \quad . \quad . \quad . \quad . \quad (2)$$

where

A_s = area for superheated steam in square inches,
A = area for saturated steam in square inches,
T_s = degree of superheat in deg. Fah.

The area of this valve has been computed from the formula

$$A=\frac{\pi}{2}(D+d)\sqrt{L^2-L(D-d)+\frac{(D-d)^2}{2}} \quad . \quad . \quad (3)$$

where

D = the outside diameter of the mitre of the seat,
d = the diameter of the valve lid (see Fig. 7).
L = lift of the valve.

For the valve under test :—

$D=2\frac{25}{32}$in and $d=2\frac{1}{4}$in.

The maximum lift recorded was $^{29}/_{64}$in. Inserting this dimension in formula (3), a value of 2·845 square inch for A is obtained.

The test results at $4\frac{1}{4}$ minutes after the start

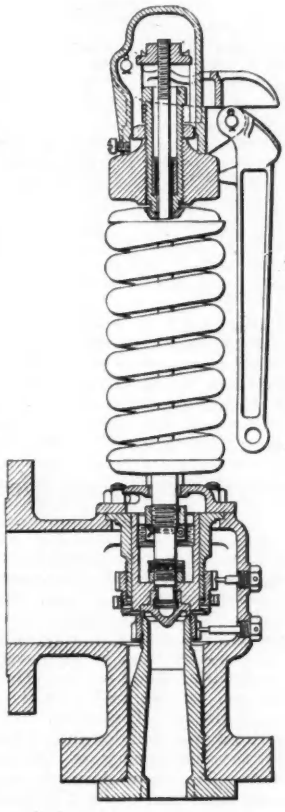


FIG. 8—"MAXIFLOW" SAFETY VALVE

of the test are taken as an example to find the correct constant.

Flow as recorded	75,500 lb per hour
Pressure at flowmeter	688 p.s.i.
Temperature at flowmeter ...	900 deg. Fah.

Therefore pressure and temperature correction factor (flowmeter) = 0·961.

Correct flow = 0·961 × 75,500 = 72,540 lb per hour.

To obtain the correct area for temperature condition at test :—

T_s = 900 deg. − 503 deg. = 397 deg. (where 503 deg. is saturation temperature at 688 p.s.i.).

Thus, inserting 2·845 for A_s and 397 for T_s in formula (2), we obtain :—

$$A=\frac{A_s}{\sqrt{1+\frac{1\cdot5T_s}{1000}}}=\frac{2\cdot845}{\sqrt{1\cdot596}}$$

$$=2\cdot252 \text{ square inches.}$$

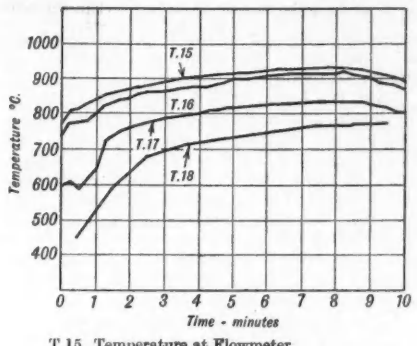
therefore from (1)

$$C=\frac{E}{AP}=\frac{72{,}540}{2\cdot252\times665}$$

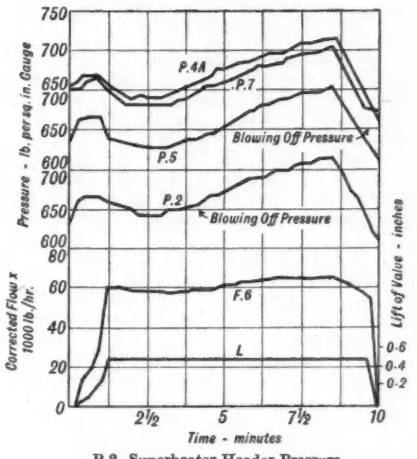
$$=48\cdot5,$$

where 665 is the set pressure in p.s.i. abs.

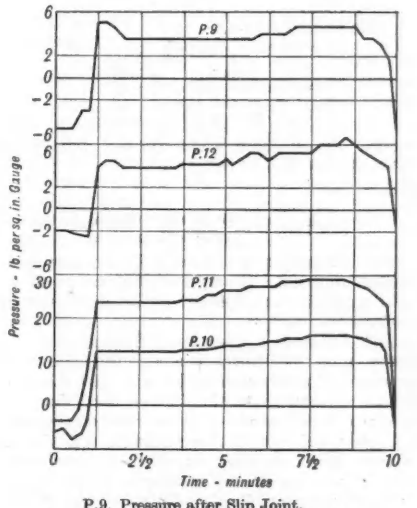
Thus, repeating the same calculations for all readings from $3\frac{1}{2}$ minutes to $5\frac{1}{4}$ minutes, an average constant of 48·63 is obtained with a



T.15. Temperature at Flowmeter.
T.16. Temperature at Safety Valve Inlet.
T.17. Temperature after Slip Joint.
T.18. Temperature at Escape Pipe Outlet.



P.2. Superheater Header Pressure.
P.4A. Drum Pressure.
P.5. Pressure at Flowmeter Nozzle.
P.7. Pressure at Safety Valve Inlet.
F.6. Flow of Steam.
L. Lift of Valve.



P.9. Pressure after Slip Joint.
P.10, 11. Pressure at Safety Valve Outlet.
P.12. Pressure at Escape Pipe Outlet.

FIGS. 9, 10 AND 11—2½IN "MAXIFLOW" SAFETY VALVE TEST

maximum of 48·81 at 5 minutes and a minimum of 48·45 at $3\frac{3}{4}$ minutes.

"MAXIFLOW" VALVE TEST

A second test was carried out on the new design of safety valve which will be marketed under the trade name of "Maxiflow." It is a

full-bore safety valve, shown in Fig. 8, and has been specially designed to function with a blowdown which can be much lower than used with other types of valves, and in certain circumstances can be as low as 1 per cent. This design necessitates the use of three special blowdown adjusting rings. The use of the three rings is, briefly, as follows :—

There is a lower, or pop, ring, which controls the closing action, an upper or outer ring which controls the opening action, and a trim ring which regulates the flow of steam through a series of holes drilled in the circumferential belt around the lower section of the outer ring ; the trim ring only functions after the disc is lifted sufficiently to uncover the series of holes. With this ring it is possible to obtain close accuracy in regulating the flow of steam to give the exact reaction effect required.

The "Maxiflow" valve has a flat seat and, as with the full-lift valve, a thermodisc design has been incorporated. The design of the seat bushing is such that the joint is made between the seat bushing flange and the boiler stool flange. A safety deflector plate is fitted to prevent steam from reaching the spring and thus cause overheating when the valve is blowing. To reduce the weight it was found advantageous to incorporate pillars and a bridge piece in the design, in place of the more conventional casting. In the "Maxiflow" valve the discharge area is equal to that of a nozzle of the same diameter as the bore of the valve, and it is only due to the restriction at the outlet of the nozzle that the safety valve efficiency is not as great as that of an unrestricted nozzle.

The results of the tests on the 2½in "Maxiflow" safety valve are shown in Figs. 9, 10 and 11. The bore through the seat bushing is 1·8in. The lift of the valve obtained during the test was 0·45in.

Typical figures taken at five minutes after commencement of blow are tabulated herewith :—

Flowmeter reading	64,500 lb per hour
Pressure reading	659 p.s.i.
Temperature reading	915 deg. Fah.
Flow correction factor	0·933
Corrected flow = 0·933 × 64,500	60,200 lb per hour

It can be shown that the effective area of the valve is not increased where the lift exceeds 0·385in.

The maximum discharge area is $\frac{1\cdot8^2\times\pi}{4}$ = 2·545 square inches.

Correcting for superheated steam,

$$A=\frac{2\cdot545}{\sqrt{1+\frac{1\cdot5\times416}{1000}}}=\frac{2\cdot545}{1\cdot275}$$

= 1·997 square inches, where 416 deg. Fah. is the degree of superheat at 659 p.s.i.

and

$$C=\frac{60{,}200}{1\cdot997\times655}=46\cdot05,$$ where 655 is the set pressure in p.s.i. abs.

The average constant after 1¼ minutes have elapsed and until the end of the test is 46·47 with a maximum of 48·91 and a minimum of 44·77.

The Associated Companies Technical Committee and the insurance companies who were represented at these tests have agreed that the following constants should be used for the safety valves tested :—In the case of the full-lift safety valve for boiler units with a minimum of two drum safety valves and one superheater, $C=40$; where a greater number of safety valves are used per unit, $C=44$; for the "Maxiflow" valve, $C=38$ and 42 respectively.

ACKNOWLEDGMENT

The manufacturer, Dewrance and Co., Ltd., acknowledges the assistance given by the British Electricity Authority, Babcock and Wilcox, Ltd., and Bailey Meters and Controls, Ltd., in the planning and execution of the tests referred to in this article.

SHIPYARD RECONSTRUCTION.—To meet the demand for large tankers, Sir James Laing and Sons, Ltd., is to reconstruct a second berth in its Deptford yard, Sunderland, to accommodate vessels up to 23,000 tons deadweight.

Installation of New Generating Plant in 1950

NEW generating plant installed by the British Electricity Authority in the year ended December 31, 1950, amounted to 1034MW (which is more than in any previous year), bringing the aggregate installed capacity of the power stations owned or operated by the Authority to 14,557MW.

Corresponding figures of plant installed during 1948 and 1949 are 503MW and 826MW respectively. The highest pre-war installation of plant was in 1938, when 761MW of new capacity was added to the supply system. The additional output obtained from the 1034MW of new plant commissioned last year was 923MW. The difference is accounted for by limitations of boiler capacities and other causes. Altogether, twenty-three new turbo-alternators and forty-five new boilers were brought into operation. The details are as follows :—

Name of station	Generating plant, Number and capacity in MW	Boilers Number and capacity, lb/hr
Agecroft, Salford, Lancs ...	2×52 ...	2×315,000
Cliff Quay, Ipswich	2×45 ...	1×365,000
Clyde's Mill, Glasgow	1×30 ...	2×180,000
Croydon	2×52 ...	2×320,000
Dunston "B," Durham ...	1×50 ...	2×410,000
Ferrybridge, Yorks	1×45 ...	4×180,000
Hartshead, Cheshire	— ...	1×150,000
Hayle, Cornwall	1×20 ...	1×260,000
Kearsley, Lancs	— ...	1×173,000
Kingston "B," Surrey ...	1×30 ...	3×260,000
Leicester	1×31 ...	2×175,000
Littlebrook "B," Dartford, Kent	1×60 ...	2×265,000
Llynfi, near Cardiff	— ...	1×300,000
Neepsend, Yorks	1×50 ...	1×190,000
Nottingham	1×52 ...	4×320,000
Poole, Dorset	1×50 ...	1×300,000
Portobello, Midlothian... ...	— ...	1×450,000
Rotherham	1×30 ...	—
Staythorpe, near Newark ...	2×60 ...	5×240,000
Stourport "B," Worcs ...	1×60 ...	1×525,000
Thornhill, Yorks	1×45 ...	1×180,000
Walsall, Staffs	1×30 ...	2×150,000 and 2×180,000
West Ham	1×30 ...	3×180,000

James Watt International Medal

THE Council of the Institution of Mechanical Engineers has awarded the 1951 James Watt International Medal to Dr. H. H. Blache, of Denmark, for his contributions to the advancement of mechanical engineering, and particularly his pioneer work in the development of the large marine diesel engine. Dr. Blache was nominated for the award by the Danish Society of Engineers. The James Watt International Medal was founded in 1936 to commemorate the bicentenary of the birth of James Watt. The award is made every two years to an engineer of any nationality who is deemed worthy of the highest honour the Institution of Mechanical Engineers can bestow and that a mechanical engineer can receive. In making the award, the Institution has secured the co-operation of the principal engineering societies in all parts of the world as nominating authorities.

NATIONAL COLLEGE OF RUBBER TECHNOLOGY.—Work has begun on the construction of a new building for the National College of Rubber Technology on a site adjoining the Northern Polytechnic, London. The estimated cost of the new college, including equipment, is about £170,000. Until the new building is ready for occupation in 1952, the college will continue to be housed in the Northern Polytechnic, where it has been since its inception in 1948. The college was set up by the Ministry of Education at the request of the rubber industry as part of the Ministry's policy to provide national centres for advanced technological education to meet the needs of industries of high national importance, requiring comparatively small numbers of trained technologists. The new premises will be linked with the Northern Polytechnic at floor levels so that students may have easy access to the departments where they will have instruction in chemistry, physics and mathematics.

The Training of Craftsmen*

By JOHN LOXHAM, M.I.Mech.E.†

THERE is abundant evidence that, in spite of the vast sums spent on education, the engineering industry of Britain is not being supplied with a sufficient number of highly skilled craftsmen. This unfortunate fact is affecting high management policy as well as the design of machine tools. The main aim in many organisations is so to plan the production programme that the work can be done by unskilled and semi-skilled workers. This short-sighted policy may assist in overcoming immediate difficulties, but nations or individuals will surely reap what they sow and, if such a policy is pursued here for a sufficiently long period of time, the skill of the people will deteriorate and a manufacturing system will be created which can be copied by nations satisfied with a low standard of living—to their considerable benefit and to this country's grievous harm.

Some of the main causes for the serious falling off in the number of highly skilled craftsmen in the engineering industry will be found to include the following :—

(1) Insufficient difference between the earnings of skilled and semi-skilled workers, destroying the incentive to the young entrant into industry to study and to train in order to become a highly skilled person.

(2) The creation of foolproof machines which require an operator who is little more than a machine loader.

(3) The transfer of all forms of production planning from the factory floor to works offices.

(4) Employers' associations setting too low a standard as the minimum standard of training to be given to trade apprentices.

(5) Restrictive practices by trade unions designed to prevent one man doing work embracing the skills of two trades.

(6) The erroneous belief that when a person, by the use of his hands and certain mechanical aids, produces a required result he is not using his brain.

(7) The erroneous belief that all office work demands more intelligence and more mental concentration than factory work.

(8) The lack of any craft guilds, institutions or associations where membership is restricted to persons of proved high craft qualifications.

(9) The almost complete lack of satisfactory technical training for the study of the sciences associated with engineering production, and inability to adapt the educational structure to the ever-increasing practical requirements of a machine age.

(10) The above and like circumstances resulting in parents, teachers and, in particular, grammar school headmasters advising youths of high intelligence that in spite of inherent craft skill they must plan to spend their working life at some form of office work.

If workers in Britain are to enjoy a high standard of living, education and training must be so planned that for the expenditure of a relatively small amount of time, material and capital, a large amount of real wealth is produced. To this end the two extremes must be discarded whereby, in one case, a person using obsolete equipment and old specialised skills produces a small number of articles at a high cost for a very limited market, and, in the second case, where a semi-skilled or unskilled person operates a highly complex machine to produce articles of medium or poor quality at a high rate of production. Productivity can be considerably increased by acknowledging the importance of intelligent and highly skilled persons taking proper pride in the part they play on the factory floor in controlling devices, in some cases simple and in other cases complex, and by their high skill, intelligence and diligence producing a product that, as compared with the time, material and capital employed, has resulted in a considerable increase in real wealth. To achieve this end it will be necessary for all parties, and, in particular, employers' associations, trade unions, technical colleges, the Ministries of Education and Labour, the

* Institution of Mechanical Engineers. January 23rd.

† Managing director, Sigma Instrument Company, Ltd., Letchworth.

City and Guilds Institute, and the professional institutions to co-operate with good will and a genuine desire on the part of the individuals concerned to use their considerable influence as a means whereby they may serve their country and their fellow men. Such a policy is not likely to be detrimental to any of the interests concerned because full and complete co-operation will result in an increase of efficiency which will react to the benefit of all.

In formulating their plans the parties concerned should first become familiar with the proposed changes which are likely to take place, and in some cases already have taken place, in Britain's educational system. The sections deserving special study are those concerned with secondary and further education. The Minister's intentions in these matters are well and fully described in the following publications, all of which are available from His Majesty's Stationery Office, York House, Kingsway, W.C.2, or from any bookseller :—

(1) 1945 : "Higher Technological Education." Report of a Special Committee appointed April, 1944. Price 6d. net.

(2) 1944 : "Education Act, 1944." Price 2s. net.

(3) 1946 : "Education Act, 1946." Price 4d. net.

(4) 1945 : "Youth's Opportunity : Further Education in County Colleges." Ministry of Education Pamphlet No. 3. Price 1s. net.

(5) 1947 : "Further Education." Ministry of Education Pamphlet No. 8. Price 2s. net.

(6) 1947 : "The New Secondary Education." Ministry of Education Pamphlet No. 9. Price 1s. 6d. net.

(7) 1947 : "Education for Management." Report of Special Committee appointed by Minister of Education. Price 6d.

A careful study of the above documents reveals that future entrants as apprentices to the engineering industry are likely to come through the three channels of secondary grammar schools, secondary technical schools, and secondary modern schools. The age of young persons leaving these schools will be sixteen plus in the case of the grammar schools and fifteen plus in the cases of the secondary technical schools and secondary modern schools. When the 1944 Act is put into full operation the leaving age of the latter two groups will also be sixteen plus.

It would be to the benefit of the industry as a whole if, possibly under the leadership of the Ministry of Labour, the trade associations, employers' federations, and the trade unions established a common scheme for entry of apprentices into the engineering industry. This should include a standard form of indenture, in which the official document should be of dignified appearance. The various crafts should be classified into a small number of groups and there should be liberal overlap especially between the mechanical and electrical trades. Each group would have its own standard as the minimum standard of training to be covered by apprentices in that group. Firms not able to conform to the standard should be encouraged to combine with other firms in the locality so that a transfer of apprentices could occur to broaden the training. If this proved impracticable, firms unable to conform to the standard should not undertake the training of apprentices.

Steps should be taken to destroy the idea that persons of low intelligence make good craftsmen. To assist in increasing the prestige of the trade apprentice, arrangements should be made for all entrants for apprenticeship at approved firms to pass an entrance examination. Such an arrangement would tend to increase the number of applicants because there would be an increase in the number of boys from grammar and technical schools applying for apprenticeship. In considering the type of examination, account should be taken of the educational background of the applicant, and the examination set for the grammar school boy would differ from that set for the boy from a secondary modern school.

The next step to consider is the type of practical training to be given, and it is recommended that the first two years be spent in a works school, where this is possible, and in all cases under the personal supervision of a carefully selected and highly skilled craftsman. Some production work could be undertaken in the school, but it should be selected for its training rather than its production value. Transfer from one class of work to another should occur at approximately three-month intervals. To ensure a full and truly balanced training, about half of the training period in the first two years should be spent working on exercises in the school, and about half on selected automatic or semi-automatic production machines operating at full production speed. The purpose of sending the young apprentice for short periods into the production departments is to enable him to become familiar with speeds, feeds and production rates which must be operated on production, and to experience for himself the feeling of monotony which, in some cases, accompanies medium and large-scale production.

During this period of practical training the apprentice should undertake an approved course of theoretical study designed to occupy one full day and one evening per week. The courses of study should vary to suit the ability and aspirations of the apprentice, and the following is suggested as a suitable grouping :—

Group 1.—Persons of high intelligence who are desirous of undertaking a heavy programme and who, by their own efforts and self-sacrifice, hope to become highly qualified in both the practical and theoretical sections of the trade, should take a joint Ordinary National Certificate Course leading to the award of an Ordinary National Certificate in Mechanical Engineering and an Ordinary National Certificate in Electrical Engineering. The course should be planned to occupy a period of three years, and, in addition to the above, there should be included a liberal amount of workshop technology.

This latter section of the course could, in some instances, be undertaken, in part or in full, by the works school, and, where this is not practicable, arrangements should be made for the additional necessary teaching hours to be obtained by additional attendance at the technical college. It is probable that during or at the end of the first year of this course some apprentices will find that the work is proving to be too difficult and provision should be made for them to transfer into Group 2, during the session if this is necessary and at the commencement of the second year if first-year records indicate this to be desirable.

Group 2.—This group is designed to provide training for those who are unable to undertake the highly concentrated and difficult programme set out in Group 1. The course should aim at only one Ordinary National Certificate in addition to a liberal amount of workshop technology. The first year of this course should be carefully planned and should not include a large amount of academic work. It is likely that some apprentices who are unfit for the full National Certificate Course will attempt this course, and, if the academic standard is too high, they will gain very little from their study. At the end of the first year, it should be possible with the fuller knowledge of the student's capabilities, as shown by his first year's work, to arrange for the second year to follow any of the following three alternatives :—

(*a*) Transfer to Group 3.

(*b*) Continue in Group 2, which, in the second and third years, should contain a greater percentage of academic work to compensate for the easy first year.

(*c*) Transfer to Group 1. To do this will involve additional study, but courses can and should be arranged so that the few necessary transfers to higher grade work can take place.

Group 3.—This group is designed for the apprentice who, from the outset, wishes to concentrate on the study of actual manufacture. The course should be planned to give the apprentice an elementary, but accurate, understanding of the fundamental laws underlying the trade he has elected to follow. Electrical and mechanical devices are to be found to an increasing extent in modern machines and instruments, and this trend is likely to continue and probably to increase. The well-trained engineering craftsman should not be ignorant of the elementary laws of electricity and magnetism, no matter what his trade. Examples from mechanics, hydraulics and pneumatics should also be included in addition to a thorough training in workshop technology, metrology, &c. For this course some qualified person or persons should be given the all-important task of designing and writing up in considerable detail a series of experiments which, when available, can and should be used on a national scale. The waste of time and potential skill which is lost by our refusal to undertake this task on a national basis cannot be even partially appreciated, or we should take positive steps to effect a speedy remedy.

At the end of the second year the main practical training of basic skills should be completed and the apprentice should, during the next three years, gain experience in the use of these skills on production and become a profitable production unit. Apprentices who have made satisfactory progress with their theoretical study should be allowed to continue this study with one full day release with full pay. Daytime release should be discontinued for those who do not obtain real benefit from their studies and they should be encouraged to concentrate on the acquiring of a high degree of craft skill in a restricted field if this appears to be necessary. It is at this stage that the apprentice supervisor should study with special care the progress of the apprentice and plan to extend or provide for such specialisation as appears to be in the best interests of the apprentice, with the one object that, at the end of the period of training, each human being has been well trained for a position for which by his ability and natural aptitude he appears to be well suited.

It is at this stage that the company employing the apprentice should support an application made by the apprentice for deferment from military service. This will ensure that the training period is completed without interruption. When the apprentice is finally called to military service he should be given a letter from the apprentice supervisor designed to increase the possibility of the apprentice being drafted into a section of the armed Forces where his skill can be used and consequently improved during his service.

At the end of the third year, special study should be given to the apprentices in Group 1. At this stage there are a number of alternatives open to these men. They may be summarised as follows :—

(1) The apprentice under review will be nineteen plus. He will have worked for at least three years in industry and have received theoretical teaching in the part-time day and evening courses. He will have reached a certain maturity. It is likely that he will have decided in which section of the engineering industry industry he hopes to specialise. Provision should, therefore, be made for him to take a Higher National Certificate in a specialised subject, such as mechanical engineering, electrical engineering, or production engineering, any of which may be given a strong local bias (such as instrument making, if the number of students makes the provision of such a course possible).

(2) It may be that some students by this time will have shown promise of high academic attainment and they are likely to be satisfactory persons for employment in research departments or engaged on fundamental design of equipment requiring such qualifications. Students of this type should be accepted by some of the leading universities, and the Ordinary National Certificates in Mechanical and Electrical Engineering, together with appropriate preliminary study, should be accepted as equivalent to intermediate B.Sc.

(3) A further group of students may be given full-time theoretical training in subjects which are more associated with the practical requirements of the engineering industry than the standard university course. These men could be catered for in the new Colleges of Technology as recommended in the report on higher technological education.

(4) It is at this stage that the employer, with the assistance of the educational authorities, should be able to select the specially

brilliant few who, by virtue of their high performance both in the art and science of their profession, together with their marked qualities of character, integrity and leadership, are destined to occupy a high place in industry.

It is in the interests of the industry and of the nation that about ten such men per year should be withdrawn from the main sections of the engineering industry to undergo a three-years' course of specialised training at a National College dealing with the specialised arts and sciences associated with their particular profession. The common preparatory course in the form of the joint Ordinary National Certificate course in Mechanical and Electrical Engineering will provide a common basis from which to plan their further training. It is the duty of the industry and the educational authorities to undertake the planning of these higher courses as one of their most important and urgent tasks. The course under review would be different from, but in no way inferior and in some respects superior to, a normal B.Sc. course and successful candidates should receive a nationally recognised award such as B.Tech.—a qualification which industry would soon learn to value as different from B.Sc., but the hallmark of a highly and fully trained engineer.

Persons completing such a course should be accepted by the universities as men qualified to study for higher degrees, but the majority would wish to return to industry and serve the profession which gave them their exceptional training. It is to such men that the industry can look with confidence for skilled, courageous and wise leadership.

The apprentices in Group 1 are not likely to exceed 20 per cent, and the majority of the skilled craftsmen will be in Groups 2 and 3. Apprentices in Group 2 should take the Ordinary National Certificate examination and those in Group 3 the Intermediate Examination of City and Guilds of London Institute.

If the results of the above examinations indicate that the apprentice is receiving real benefit from the course of theoretical study, arrangements should be made for him to continue for two years with one day per week release from work at full pay during the apprenticeship period, and at half pay if the period extends beyond his twenty-first birthday. Apprentices in Group 2 might take one additional year's study to obtain the double Ordinary National Certificate, which should be followed, if possible, by two years' study to obtain a Higher National Certificate in a specialised subject. Alternatively, an apprentice should take at once a two-year course to obtain a suitable Higher National Certificate. Apprentices in Group 3 should take a further two years' study to obtain the Final Certificate of City and Guilds of London Institute.

If the above scheme were followed, there would emerge from our technical college and workshops a yearly group of men who would have received a training designed to suit their natural instincts and capabilities. There would be many categories, and this is desirable. Some would have high academic attainments, but, more important, all could be classed as thoroughly trained, and a large percentage as highly skilled craftsmen.

Some positive steps should be taken to give a national award to persons complying with the requirements of an approved national scheme designed to produce highly skilled craftsmen. It is suggested that the award be given the title of National Certificate in Craftsmanship, a certificate to be awarded to persons who have:

(1) Completed an indentured apprenticeship with an approved firm to the satisfaction of his employer and trade association; and

(2*a*) Obtained an Ordinary National Certificate in Mechanical or Electrical Engineering, endorsed to indicate that a specified minimum amount of workshop technology has been included in the course and the examinations; or, alternatively,

(2*b*) Obtained the Final Certificate of City and Guilds of London Institute in an approved subject directly related to the trade to which an indentured apprenticeship has been served.

The certificate awarded should be imposing in appearance, it should be signed by the president of the appropriate trade association, the employer, and a high official of the authority sponsoring the theoretical training.

It is inconceivable that this great Institution, whose founders and early members appreciated the importance of craftsmanship and whose National Certificate scheme has been almost embarrassingly successful, should fail to take a leading part in promoting a scheme for which thousands of British engineers of all grades would, in future years, be profoundly thankful.

The author has endeavoured in the paper to suggest means by which the several organisations that contribute to the training of the large group that enter industry at fifteen plus and sixteen plus can integrate their efforts into a common scheme. It is hoped that persons qualified to add to, or constructively criticise, these proposals will do so, and that one result of the consideration given by the Institution to this important matter will be a positive step taken in the direction of providing a remedy for what, in the author's opinion, is a serious and avoidable defect in Britain's engineering structure.

A Century of British Industry*

By LORD McGOWAN, K.B.E.

In 1851 Great Britain was known as "the forge of the world, the world's carrier, the world's banker, the world's workshop, the world's entrepot." None of that is true any longer. The foundations of our leadership were beginning to crumble as far back as 1870 and we had lost it in all but name by 1914. But if success is to be measured by the results of our endeavours to wrest a better living for our people from the material world, then we have no reason to be ashamed of our performance.

The better standard of living which our people enjoy to-day has been obtained by an increase in productivity—which is very different, of course, from a mere increase in our total output. It means that the same working population is producing more goods and services in a given period of work. In consequence it has become technically possible to advance beyond mere provision of the necessities of life and to devote more and more of our production to luxuries. Radio and television sets, motor-cars, electric irons and refrigerators and nylon stockings—all these are either within the reach of the mass of our people or would be soon if we were not being forced to indulge in a vast rearmament programme, which may have the effect of curtailing the luxuries to which I have referred.

If we look at the distribution of manpower we see that industry has made it possible for a larger fraction of our population to devote itself to the professions, to administrative work and, in general, to occupations other than that of direct producer. Thus the structure of our economic and social life has become more highly organised, more specialised and more efficient.

Up to a point, therefore, British industry may be said to have been successful in the last hundred years, but in the course of them we have been forced to surrender the industrial crown. That crown is now worn by the United States of America. This was bound to happen and the *Economist* said so as long ago as 1851. In its issue of March 8th for that year it affirmed that: "The superiority of the United States to England is ultimately as certain as the next eclipse."

There is no evidence that our people are less capable than America's given equal conditions of work. The U.S.A. has, of course, a much larger home market, but I do not believe that this is, or has been, a decisive advantage. It is also true that the U.S.A. is much more richly endowed with the raw materials that feed industry. That is an advantage which we cannot circumvent, but it does impose upon us the obligation to discover all the natural wealth of this old country and we have not done so yet. We have a long way to go before we will have tapped all the hydro-electric power available in the Scottish Highlands and it is only a few months ago that my company's engineers reported the discovery in North Yorkshire of at least 200,000,000 tons of potash—a strategic material that has had to be imported at great cost up to this time. So far as natural resources are concerned, our gravest disadvantage to-day is that we are not raising our coal, which we still have in abundance, either cheaply enough or in sufficient quantity. Here we are, five years after the end of the war, actually buying coal from abroad and threatened with a winter shortage at home! We cannot look to atomic energy to help out our power resources for a long time to come. More's the pity. It may be five years before the first pilot power pile comes into operation and piles to generate power on a commercial scale are still further away.

Last, but not least, the two world wars have dealt heavy blows at our economy, whereas their effects on the U.S.A. have been much the reverse. We have come through very bad times and even when full allowance is made for American and Canadian assistance, there is still much of merit in our recovery.

We have, however, one fundamental weakness which we can and must overcome. It is epitomised in the story of William Henry Perkin, the young chemist, whose discovery of mauveine laid the foundations of the dyestuffs industry throughout the world. It is now ancient history, as they say, that we failed to exploit Perkin's discovery, but left it to others. This sort of thing has happened all too often. We are second to none for richness of invention but we frequently fail in the follow-up—that is to say, in visualising the potential of the fruits of research and giving them practical application in industry.

One purpose of examining the history of what has happened in the past is to try to draw from it guidance for the future. I would suggest, therefore, that we must give serious consideration to the steps required to ensure, as a matter of national policy, the practical application of scientific knowledge to industry. I believe that there are two essential parts to such a policy.

First, I would like to refer to the argument developed by my colleague, Sir Ewart Smith, in a paper which he read last September to the British Association. He spotlighted the essential difference between the industrial forces of Great Britain and the United States—that is, our numerical deficiency in applied scientists. This is the trained manpower without which new knowledge cannot be applied to productive purposes. Sir Ewart pointed out that American universities were producing more technologists than pure scientists, whereas in this country in 1949 degrees in Applied Science represented only some 12 per cent of the total in all faculties. If we are to increase the number of Applied Science graduates it will involve changes, he said, not only in the universities but also in the schools. Boys in their formative years will have to be steered towards, and not told to shy away from, a desire to acquire knowledge for practical ends. The old idea that a career in Applied Science in industry is inferior in status to other professions must be killed stone dead if we are to meet the challenge of the times. Moreover, the increase in technological skill should not be confined simply to graduates. What is required is an upgrading of technical training at all levels, from apprentice to manager.

If we accept an increase in overall national productivity of not less than 5 per cent per annum as our objective, then a similar rate of increase is required in the supply of graduates and others with the necessary applied scientific training. This proposal involves a radical shift in the balance of our educational system. It means, for example, that technical colleges would have to be upgraded to share the burden with the universities. But if it is achieved, and the larger number of trained men and women are forthcoming, we shall still have to see that they are absorbed into industry and employed to the best purpose. It is true that many companies in this country fully appreciate the need to strive continuously after greater technical proficiency in production,

* Trueman Wood Lecture. Royal Society of Arts Extract.

but not all. If our educational system puts greater emphasis on the practical application of science, this will, of course, help to mould the outlook of management along the desired lines.

In the meantime I think we will have to make a strong and well-reasoned appeal to management to absorb these new men of industry as fast as the supply allows, so that more and more young men will be encouraged to follow the same path. Once this stage is reached, we shall be in a far better position to begin redressing the balance between American productivity and our own. Moreover, we will then be able to regain the initiative in setting up new methods and new lines of production. Only in this way can we hope to keep ahead of the younger industrial nations and have new products to offer in place of those which tend to decline in importance in international trade as the young countries begin to make for themselves.

I only find confirmation for my opinions when I read the reports of our productivity teams returning from the U.S.A. Running all through these reports, whatever the industry concerned, there is the same theme—namely, that they have an entirely different psychological attitude to production in the U.S.A. Americans seem to have a fervent belief—one might almost call it a religion—that the discovery of faster, cheaper ways of doing a job and making better products for the service of man, is everybody's business. I am afraid that we in this country are much too conservative.

I see from your programme that you are shortly to hear an address on "A Century of British Science," so I must not stray far into another's territory. But before I close I would say that we should not continue to hide our light under a bushel; we have much to be proud of in the realm of science. Britain's contribution has not faltered; in recent years it has been as abundant as ever. It was Britain that gave the world the steam engine, then the locomotive, then the turbine, and now, through the genius of Sir Frank Whittle, we have given the world the jet, which is destined to revolutionise travel just as much as the railways were doing in 1851. The world owes radar in large measure to Sir Watson Watt and the discovery and development of penicillin to Sir Alexander Fleming and Sir Howard Florey. What other nation can to-day point to four men of comparable genius to these? Not one! They are the living proof that with the passage of the years we have not lost the qualities necessary for permanent leadership in many fields. Surely we must be proud of what these men have accomplished and I finish on this note, that however bleak the outlook is to-day, caused by the parlous condition of international affairs, we in this country have no need to despair. Our traditions have carried us through many crises successfully for hundreds of years and will do so again—it is the spirit of the people that will determine our future—but we cannot be content only with our past traditions; we must build new ones for the future. Let us recapture the Dunkirk and Alamein spirit, which brought us through momentous phases in the last war; let us face the future with the confidence, courage and optimism so characteristic of our race, which have served us so well in the past.

The Steel Industry's Raw Material Supplies

When the British steel industry's development plan was formulated at the end of the war, its aim was a production capacity by 1952–53 of 16,000,000 tons a year. Subsequent examination of the plan led to that figure being increased to 18,000,000 tons a year, which output, it was considered, could be achieved by 1955. The original objective of 16,000,000 tons has already been passed, and, in fact, a steel capacity of 18,000,000 tons is now well within sight. But, as the British Iron and Steel Federation has pointed out in the current issue of its *Monthly Statistical Bulletin*, any possibility of reaching the 18,000,000 ton level in advance of the planned date depends mainly on the rate at which raw material supplies can be further expanded.

The Federation says that the essential problem relates to the increase of pig iron production. As regards the home ore fields, expansion is proceeding at least as rapidly as was originally envisaged in the Lincolnshire area; but it has not yet been possible to expand in Northamptonshire to the extent anticipated. In that area, it was hoped to double pig iron output and, as a result, to expand steel production from 600,000 tons to 1,250,000 tons a year. Originally, the broad intention was to develop on a new site blast-furnaces and steelworks of approximately the size of Corby. But on closer examination it appeared that the best prospect of reasonably early expansion was to double the production of the Corby plant. The problem of labour supply in the Northamptonshire area, however, has proved so difficult that it has not been possible so far to plan for expansion at Corby beyond a steel production of 800,000 tons a year. The solution of the labour problem depends, principally, on the provision of houses at a considerably more rapid rate than has been the case hitherto. At present, in fact, blast-furnace capacity already existing on the Northamptonshire ore field—notably at Kettering and Wellingborough—cannot be brought into production because of insufficient labour and accommodation.

In its survey of the raw material situation, the British Iron and Steel Federation explains that the expansion of pig iron production on coastal sites is limited by the rate at which imported iron ore can be supplied. In this connection, the main possibility of expansion lies in the development of new ore fields overseas. This, of course, is a long-term project, but, in conjunction with France, developments are already proceeding at Conakry, on the West Coast of Africa, which should yield a total additional output of about 1,200,000 tons of ore a year by 1953. Long-term arrangements are also being made which should result in the expansion of ore production at Wabana, in Newfoundland, thus doubling that country's export capacity from the present figure of 750,000 tons to about 1,500,000 tons in 1952. Discussions are also proceeding with the Sierra Leone Company for the opening up of a new ore field which should eventually mean an additional supply of about 3,000,000 tons a year. Furthermore, developments which the U.S.A. is undertaking in Liberia, Labrador and Venezuela, by expanding the total supply of iron ore, should ease American pressure on European sources from Sweden and the Mediterranean, thus improving the overall British position.

The Federation emphasises, however, that behind the two key problems of labour supply in relation to home ore sites and imported ore expansion for the coastal sites is the question of adequate coke supplies. Coke availability was a serious limitation during most of 1947; at other times since there has usually been an adequate total supply, although it has often been made possible only by the use of marginal cokes of inferior quality. By the end of 1950 the growth of blast-furnace capacity in this country had again outstripped the available coke supplies, and there is thus a real problem for the immediate future of making full use of the available pig iron capacity. In the longer term, too, as is shown by the National Coal Board's recent report, special concern will be needed if adequate supplies of coking coal are to be made available to meet the increasing requirements of the iron and steel industry.

Developments in Thames Tugs

On Thursday, January 18th, Mr. F. J. Mayor read his paper, "Development in Thames Tugs," before the Diesel Engine Users' Association and a summary is given below.

In the paper, which is well illustrated, the author surveys the evolution of Thames tugs over the years and discusses the various designs of machinery which have found favour with a number of owners, for tugs performing a wide range of duties. Some early paddle and propeller driven tugs, dating back to 1861, are mentioned; many of these were fitted with a non-condensing engine, which later was superseded by the orthodox compound surface condensing engine with the boiler feed pump, bilge pump, and air pump connected to a crosshead driven by a lever from the l.p. engine. Steam was supplied by a two-furnace Scotch boiler at about 130 lb per square inch and a vacuum of 22in allowed a boiler feed of satisfactory temperature. Propeller revolutions ranged from 90 to 120 r.p.m. and older tugs used multi-collar thrust blocks. Although these vessels were reliable they were under a disadvantage in the muddy water of the Thames, due to the excessive deposit of mud in the boilers when working on open circuit.

The author states that after the first world war the first internal combustion engined tug, "Grove Place," made its appearance, the engine being of hot bulb or semi-diesel design. These craft did good work and it was not until 1929 that the first cold starting compression ignition engine was fitted, this being a four-cylinder, two-cycle, single-acting, direct reversing engine with piston scavenging and developing 350 h.p. at 275 r.p.m. Owing to the great deal of manœuvring to be carried out, a large amount of starting air was provided but the quantity was greatly reduced when reduction reverse gears were fitted because the engine ran in one direction all the time and only required air for starting up. The paper mentions that diesel engines also suffered from Thames mud and cylinder jackets and water spaces were quickly loaded with silt. This difficulty was overcome by using distilled water, treated to prevent corrosion troubles, in a closed circuit with a heat exchanger for cooling the cooling water.

Continuing, the author mentions the appearance on the river of the first diesel-electric tug, "Acklam Cross," in 1933, closely followed by the "Lectro," "Framfield" and "Robertsbridge." The latter vessels have the following dimensions: length between perpendiculars 77ft 6in, by 19ft 6in breadth moulded, by 10ft 4½in, depth moulded and are fitted with two six-cylinder engines direct-coupled to a 160kW, 350V d.c. generator, giving power to a propulsion motor developing 400 s.h.p. at 115 r.p.m. and controlled on the Ward Leonard system.

In the diesel-electric tugs it is usual to have one man in the engine-room, and for the captain to do all the manœuvring from the bridge, and in the paper it is said that the "Trinco" is the first direct drive diesel tug to have engine controls arranged in this manner. The particulars of a number of tugs are given and special reference made to the small-powered dock tugs having engines of 100 b.h.p.

The last tug described in the paper is the "Tom Jay," which was put in service in 1949 and in which diesel-hydraulic propulsion is employed. A nine-cylinder hydraulic motor drives the propeller and lubricating oil is used as the hydraulic medium. Power is supplied by three six-cylinder diesel engines, each developing 100 b.h.p. at 800 r.p.m., and driving a seven-cylinder radial pump. A maximum total pressure of 1300 lb per square inch is generated and is related to the thrust of the propeller when turning at 110 r.p.m. The engines are placed transversely in the ship and there is a fourth engine and pump, which acts as a standby. The connections of the pumps to the pressure line are such that any of the engines can be isolated without taking the tug out of service, and the whole of the machinery is under direct control from the bridge. The author states that mechanical efficiency is calculated to be 87 per cent and that the points of special interest in connection with the installation are: low fuel and maintenance costs, maximum output at the propeller for minimum input from the engines and maximum availability per annum.

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THE OPPOSED-PISTON MARINE OIL ENGINE

THE Thomas Lowe Gray Lecture, delivered before the Institution of Mechanical Engineers each year, may be regarded as both a reflection of past experience and an incentive to further development. These valuable ingredients were well mixed in the lecture delivered by Mr. W. H. Purdie, last Friday, and those who listened felt that they were being told the unvarnished tale of the development of what has come to be known as the "Doxford" engine. They may also have reached the conclusion that nothing has been more conducive to the wide employment of this engine in marine applications than the utilisation, by those who developed it, of lessons learned from long experience with steam propelling machinery of the type more or less standard in the opening decade of the present century. A marine engine differs from any other engine in that it is obliged to accompany its itinerant site all over the oceans of the world to places where it must depend, for any necessary repairs, on such equipment as may be available. There is thus a strong need for the greatest possible accessibility and convenience in dismantling and extracting heavy parts and for a design which will permit those parts to be repaired or maintained with such workshop equipment—and workshop personnel—as may be found in the normal run of overseas repair shops. It can hardly be doubted that full recognition of these patent facts by those who developed the engine has greatly contributed to its wide employment.

It is common justice to remember, when recording the strong development of any particular type of engine, the indebtedness of its manufacturers to those designers who have gone before. This is particularly true of the modern opposed-piston engine, since we must never forget that it is 117 years since that most prescient man, John George Bodmer, took out his patent for the opposed-piston steam engine. He was followed, at an interval of fifty-six years, by a Sunderland engineer (George Robson), who described an opposed-piston gas engine in which he claimed "a double-pistoned single-cylindered engine wherein the pistons travel unequal distances in opposite directions and actuate one crankshaft." Before Robson's time, Gilles, of Cologne, had developed a double-piston atmospheric gas engine, in which two pistons were assembled in one cylinder and this Gilles engine must certainly have been seen by Wilhelm von Oechelhäuser who, jointly with Hugo Junkers, patented, in 1892, the opposed-piston gas engine commonly known as the Oechelhäuser, though more accurately described as the Oechelhäuser-Junkers. Sixteen years later Junkers patented his opposed-piston, two-cycle oil engine, the general scheme of the arrangement being derived from the Oechelhäuser-Junkers gas engine. Such is the rough history of the early development of the opposed-piston engine and it is to be noted that British engineers were among the pioneers. There are, of course, many other patentees of opposed-piston engines and reference should be made to Hugh Francis Fullager, whose main patent was applied for in 1909. This brings us to 1911, when Karl Otto Keller took over the technical supervision of the oil engine department at the works of William Doxford and Sons, Sunderland. His first engine (which was of single-cylinder, single-piston, two-cycle type) was abandoned in 1912 after tests which must certainly have influenced Keller in designing the opposed-piston Doxford engine of 1914. The basic arrangement of this engine followed that of the Junkers engine. Air injection was used and the scavenge pump was direct-driven.

The development of the Doxford engine since 1914 is a story of steady practical research. Mr. Purdie told the story in his lecture, extracts from which appear elsewhere in this issue. In 1916 the engine was changed over to direct-injection and it is of interest to note that in 1920 Robert Doxford and K. O. Keller took out a patent for a further opposed-piston arrangement, in which the scheme differed considerably from that of the Junkers type. During 1921 there appeared the Doxford opposed-piston engined "Yngaren," a vessel which, after a successful career of twenty years, was lost in 1942. Following the emergence of the "Yngaren" and strongly influenced by the good results shown by the 2900 b.h.p. engine of the "Pacific Trader," the successful history of the Doxford opposed-piston engine is well known. The more intimate details of this story were modestly set forth in Mr. Purdie's lecture. It is certainly true that there can be no finality in technical progress. That remark applies particularly strongly to marine propelling machinery. A clamant present need is for the development of oil engines which will lessen the demand on the watch-keeping engineers. The shipowner is looking for engines which, in their anatomy and details, reduce the problems and cost of cleaning and maintenance; engines which, with suitable accessories, will permit of the use, without trouble, of the so-called "boiler" quality oil; engines in which the power per ton of weight can be increased without prejudice to operational reliability or to overall running cost. The Thomas Lowe Gray lectures are among the means whereby the experience of engine builders can be made available for the instruction and encouragement of engineers and shipowners alike. It is in that respect that Mr. Purdie's lecture will win the applause of all those who are concerned in maintaining and extending the reputation of British manufacturers of marine propelling machinery.

TRANSPORT RELICS AND RECORDS

SINCE a time many years prior to the nationalisation of transport the more historically inclined amongst engineers have been troubled in mind about the difficulty of making adequate provision for the preservation of railway and other transport relics. Much has, in fact, been preserved, though often it was action at the very eleventh hour that saved historic things from the scrap-heap. As a consequence of the celebration of the official centenary of railways in 1925, there even came into existence at York a museum, which was able to receive relics collected by the then existing companies, including some locomotives, particularly from the London and North Eastern Railway. But though the four main line group railways were all in one way or another interested enough to make some collections of smaller relics and to preserve a few locomotives and items of rolling stock, the collection of relics was more or less haphazardly dependent upon the work of a few enthusiasts. Moreover, the efforts of those enthusiasts were often frustrated by sheer lack of storage space. For the accommodation at York was soon used up and though some locomotives could be and were preserved at individual stations, such, for instance, as "Locomotion" and "Derwent," at Darlington, and the "Tiny" at Newton Abbot, that was not a method that could be widely adopted nor, since the exhibits would be spread widely over the country, was it capable of providing a solution really satisfactory to locomotive enthusiasts. Again, some locomotives have been preserved at the various locomotive works of the country; for example, "Coppernob" is at Horwich and "Cornwall" at Crewe. But that means of preservation is not very satisfactory since the public is likely to be unaware of what there is to see

and even enthusiasts, who are, must make a special journey and obtain permission to see the exhibits. Furthermore, it is not only locomotives that need to be preserved. Rolling stock is likely to prove as great in interest to the future historian and it requires almost as much storage space as locomotives. Nor is that all. If the transport of the past is to be adequately represented in any museum to be created in the future, space should also be found for road vehicles, omnibuses and lorries.

The coming into being of the British Transport Commission both brought discussion of these matters to a head and offered the hope that better facilities might become available for the preservation of transport relics. But the first of its actions was not wholly satisfactory to locomotive enthusiasts. At a meeting held under the chairmanship of Mr. R. A. Riddles, in November, 1948, representatives of the Railway Executive and of various interested societies and organisations came to the conclusion that apart from the continued preservation of existing historic locomotives, dependence in the future would have to be laid on the making of models of outstanding engines. The accommodation and maintenance problems inseparable from the retention of additional numbers of out-of-date locomotives and rolling stock were too acute to permit any other solution to be adopted at that time. However, the Commission recently appointed a committee under the chairmanship of its deputy secretary and on which all executives were represented, to examine the whole question of the preservation of relics and records. That committee has just reported and we have its report in front of us as we write. Its proposals for immediate action amount to a recommendation that exhibits should be centralised. Smaller exhibits, at present scattered about the country, it is suggested, might be brought to London to form the nucleus of a British Transport Museum and it is pointed out that the shareholders' meeting-room at Euston, an "imposing room with notable transport associations," could very suitably house them. There might be some exchange of relics with those already at the York Museum, which, it is considered, could be devoted particularly to relics associated with the railways of the North of England; and with the collection at Edinburgh, which could be gradually enlarged to cover transport in Scotland. Later a similar national collection might be gathered together in Cardiff.

Those proposals, though welcome, do nothing, of course, to overcome the accommodation difficulty that has for so long hindered the preservation of large relics, such as locomotives, rolling stock, omnibuses, &c. But very rightly the committee has been impressed by the fact that the early period from about 1760 to 1860 with which museums would be concerned was one "remarkable for its unique contribution to many of the arts as, for example, architecture, monumental engineering, furniture design, draughtsmanship and typography." It proposes therefore the immediate scheduling of historic transport buildings and in suggesting that, as a second stage in the policy of preserving relics and records, the Commission should acquire "a separate and worthy building" to act as the London Museum it feels "that the happiest and most appropriate arrangement for the custody and display of railway relics would be one which allowed the exhibits to be seen in a building which was itself a relic as notable as any of its contents." Attention is particularly drawn to the possible use for that purpose of the old terminus of the London and Southampton Railway at Nine Elms, "a building of great architectural distinction erected in 1838 to the design of Sir William Tite, the architect of the Royal Exchange." However, the acquirement and conversion of a suitable building might be subject to delay. The Committee therefore also recommends that in the interim some means should be found of storing large relics together in a place where, even if it were inaccessible and they could not be displayed, they could, at least, be properly cared for, pending the formation of the proposed London Museum; that all relics at present preserved and not already appropriately displayed should be taken there and that accommodation should be found there for additional worthy relics which might otherwise have to be destroyed. Those recommendations, and others not mentioned here, which are as appreciative of the desirability of preserving suitable transport relics and records, will be welcomed by all transport enthusiasts. It is satisfactory to learn that the Commission has accepted them in principle and that "though in present circumstances they are bound to keep to a minimum any new organisation such as is required for the expert supervision of their diverse and valuable relics and records, steps will be taken to appoint for that purpose a small staff, mainly from within the Commissions' undertaking."

Obituary

SIR HARRY HARLEY, C.B.E.

We have learned, with deep regret, of the death of Sir Harry Harley, of Coventry, which occurred on January 19th on board the "Dominion Monarch," in which, accompanied by Lady Harley, he was travelling to Australia. For many years Sir Harry had occupied a distinguished place in the British machine tool industry and was well known as the chairman of Coventry Gauge and Tool Company, Ltd.

Sir Harry was born on March 8, 1877, in the Hillfields district of Coventry, and began his long career in the machine tool industry when he was fourteen. He served an apprenticeship with Alfred Herbert, Ltd., and after its completion, continued to work for that firm until 1913. In that year he founded the Coventry Gauge and Tool Company, Ltd., and shortly afterwards took over full control of it. The whole of his working life was therefore spent in the city of his birth, and by far the greater part of it in the development of the business which he founded. During the second World War responsibility for a great amount of munitions production was readily undertaken by Sir Harry. He had charge of no less than twenty factories engaged in various kinds of work for the Government, and in 1942 the honour of C.B.E. was conferred upon him in recognition of his special services to the Admiralty. Two years later he became a Burgess and Freeman of the City and Royal Burgh of Brechin, Scotland, where one of his firm's factories is situated. Sir Harry was created a knight in the Birthday Honours last year.

Sir Harry was a member of the Institution of Production Engineers and was a founder member of the Gauge and Tool Makers' Association. He served as President of that Association from its inception in 1942 until March, 1947. He also took a prominent part in the public life of Coventry, and was a generous supporter of many of its organisations. Sir Harry had been a Freeman of the city since 1899. For many months he had been suffering ill-health, and it had been hoped that the voyage to Australia—to visit his company's new factory at Sydney—might help to restore him. His numerous friends in the machine tool and other sections of the engineering industry, and especially those in Coventry, will mourn his death.

A. E. RAYNER

We regret to have to record the death of Mr. Alfred Edward Rayner, which occurred at Richmond, Surrey, on January 15th. He had spent the whole of his working life—forty-five years—in the service of the Institution of Electrical Engineers. Mr. Rayner, who was sixty-three, joined the staff of the Institution as a boy, at the time when its headquarters were at 28, Victoria Street, Westminster. The Institution staff then numbered eight, and the total membership was about 7000. The move to Savoy Place was made in 1909, and Mr. Rayner was appointed an assistant secretary in 1933. He retired from that position four years ago, after a long period of faithful service to the Institution of Electrical Engineers under four successive secretaries.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

"Z" RESERVISTS

Sir,—The present lack of information about the future of officers and men who served in the Forces in the last war is not only causing unnecessary worry to their families, but is also affecting their chances of improving their experience and position.

It is a recognised fact that many engineers change their jobs in order to gain a wider knowledge of their profession or to obtain a higher salary.

Those belonging to the class "Z" reserve have lost many years of practical experience in industry, and, as quite a number of employers do not recognise any experience of professional service in the Forces, these men are at a disadvantage with those who were fortunate enough to stay in civilian employment throughout the war.

Under the uncertain circumstances of to-day it is almost impossible for a man in the class "Z" reserve to make plans or to obtain an advancement through changing his job.

Nobody who served in the last war would, of course, object to doing so again, if necessary. The present spate of rumours and the lack of guidance is a real hardship, for which there appears to be no remedy.

Capt., M.A., A.M.I.Mech.E.

London, S.W.15, January 17th.

GETTING APPRENTICES

Sir,—I feel sure that I have read in The Engineer from time to time that the industry is disturbed by the lack of training facilities for young men who wish to become fitters, &c., and that the absorption of small firms into large ones reduces the possibilities of giving good training to the young. In this brewery

company we employ about fifty fitters of various descriptions, and we do a certain amount of coppersmith and blacksmith work besides. In October last we wrote to the Secretary of the Engineering and Allied Employers' London and District Association asking him to put us in contact with any likely source of youths who might wish to become apprentice fitters, blacksmiths and coppersmiths. He replied that we should contact the Youth Employment Officer for this district. This officer replied by telephone to our application and said that apprentice pay has no attractions for parents or youths, who prefer to get £5 to £6 per week or even £8 in the tailoring industry.

I feel it would be defeatist to let the matter lie thus. I feel sure that there are large numbers of young men up and down the country who would be glad of the opportunity to learn one of these skilled trades in comparatively small and personal surroundings; moreover, my view as a layman is that the very wide variety of jobs which our engineering shops have to tackle would provide better general training for the young than the more usual specialised shops could do.

I should perhaps add that we do not have any difficulty in getting or keeping our fitters and so we do not need the young entry ourselves. The suggestion that we should take on apprentices was entirely disinterested and patriotic.

EDWARD CHADWYCK-HEALEY

Anchor Brewery,
Mile End, E.1, January 10th.

REACTIVE FORCE IN A TURBINE NOZZLE

SIR,—With reference to Mr. McLeod's letter under this heading, in your issue of January 12th, I am grateful to him for supporting my main contention and for making it clear that the forces accelerating the jet have their exact counterparts in the products of pressures and areas acting on the box. I would remind Mr. Parsons that the scope of my letter appearing in your issue of December 22nd was limited strictly to the case of a convergent nozzle.

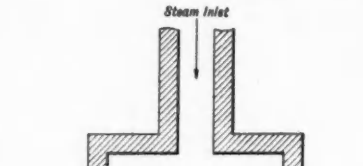
A decision having been reached as to whether absolute or gauge pressures are intended, or whether the steam is superheated or saturated, it appears that there are two remaining difficulties in the problem under consideration. The first difficulty arises from neglecting the reduction of pressure in the region of the entry to the convergent nozzle, which neglect led Messrs. Vopat and Skrotski to evaluate the reactive force as the product of the nozzle area and the pressure difference between the inside and the outside of the box. A straightforward momentum calculation indicates the amount of this pressure reduction by giving the total reactive force per unit nozzle area as $2P$ for an incompressible fluid, where P is the pressure difference between inside and outside, or as

$$2P \times \frac{\frac{\gamma}{\gamma+1}\left(\frac{2}{\gamma+1}\right)^{\frac{1}{\gamma-1}}}{1-\left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}}}$$

for a gas expanding down to the critical pressure. γ is the adiabatic index for the expansion. (For the generally accepted steam value $\gamma=1{\cdot}3$, this reactive force per unit area is $2P \times 0{\cdot}78$.)

The above description covers cases in which the external pressure is at or greater than the critical value corresponding to the pressure inside the box. The second difficulty lies in visualising how, in the case when the external pressure is less than this critical value, the jet leaving a convergent nozzle at the speed of sound can be further accelerated (the "remarkable phenomenon" mentioned by Mr. McLeod), with, at the same time, a corresponding increase in the reactive force on the box.

The accompaying diagram shows the nozzle box illustrated in Fig. 5-20 on page 171 of "Steam and Gas Turbines," by Skrotski and Vopat. As a particle of steam travels away from the nozzle throat, news of the lower external pressure reaches it transversely across the jet. It expands and its pressure falls. The energy represented by this transverse expansion is lost for the purpose of increasing forward velocity, in the absence of an enclosing divergent passage, but the thus-created longitudinal pressure gradient means that the particle will



have its momentum increased by forces whose integrated effect per unit nozzle area is equal to the pressure difference between throat and outside.

With regard to forces acting on the box: internally they are unaffected by reduction of outside pressure below the critical value; externally they equilibrate themselves everywhere at all pressures except at the wall area opposite to and equal to the nozzle area. Across this area a reactive force is developed whose value depends on the outside pressure. For outside pressures below the critical there is, therefore, an additional force to be added to the value previously quoted by you, Sir, in order that the total reactive force on the box may be obtained. This force additional to that due to expansion down to the critical pressure has a value identical to the force accelerating the jet beyond the nozzle, namely, for unit nozzle area, the pressure difference between throat and outside.

A. C. HUTCHINSON

Bedford, January 19th.

Literature

SHORT NOTICES

Kent's Mechanical Engineer's Handbook. Twelfth edition. Volume I: Power. Edited by J. Kenneth Salisbury. Volume II: Design and Production. Edited by Colin Carmichael. London: Chapman and Hall, Ltd., 37, Essex Street, Strand, W.C.2. Price 68s. each volume.—The two volumes which now form this well-known handbook contain such a vast amount of information that it would not be possible to even begin to enumerate their contents in the space available. It must suffice to say that the new edition gives in detail all the data which a mechanical engineer needs to have at hand and that it is as comprehensive and detailed as its predecessors. The power volume is designed to cover the entire field of heat power engineering and transportation as well as the important aspects of fluid flow. The design and production volume is intended for the use of designers and manufacturers of machinery, appliances, mechanical equipment and other engineering products. Both volumes have been practically rewritten by teams of experts in the various subjects covered and, in addition to being compiled in the light of modern practice and based on the latest information available, much new data on new industrial development work has been added to the subject matter. Although the data and tables given are mainly based on the practice and requirements of engineers in America, engineers in this country will find the new edition of the book a valuable reference work to have in their libraries. An excellent index in each volume provides a useful guide and assists the user of the handbook to find quickly and easily the information he seeks.

Manufacturing Processes — Materials and *Manufacturing Processes — Production.* By S. E. Rusinoff. Surrey: Technical Press, Ltd., Gloucester Road, Kingston Hill. Price 40s. and 42s. respectively. — These two complementary volumes cover a very wide field of American industrial equipment and processes. The first volume deals with the processes and equipment used in the production of units, components, &c., which form the basic requirements of industry. In it are described the various casting processes for metals; hot and cold forming of metals; welding, brazing, &c; heat treatment, powder metallurgy, and plastics and plastic moulding. The second volume, which deals in detail with machine tools of all types and their operation, tooling, &c., completes the picture of the industrial manufacturing process in its detailed description of machinery and processing of the materials.

Institution of Sanitary Engineers

ON Wednesday, January 10th, the President elect of the Institution of Sanitary Engineers, Mr. W. Fillingham Brown, was inducted by the retiring President, Mr. N. Campbell-Little, at a meeting of the Institution at Caxton Hall. Mr. Fillingham Brown then delivered his presidential address, in which he discussed some of the problems which the sanitary engineer will have to face in the years to come. His address covered a wide field, and included remarks on sanitary services in buildings, water supply and distribution, river pollution and sewerage and sewage treatment, this last subject being dealt with in greater detail than the others. In his opinion, future developments in this field were almost certain to be along the lines of extension, regionalisation and improvement of the existing system, and that its scope would be enlarged to include all domestic wastes, not only those which now find their way into the sewers but also those that are at present deposited in dustbins. In the field of sewage treatment, the President remarked that it was difficult to visualise any fundamental changes in the principles adopted. The most likely advances in the separation of the solid content from the liquid part were in the direction of greater sedimentation efficiency through improvements in the design of tanks, and one of the greatest needs in this field was systematic research on the complex problem of continuous settlement tanks. It was in the disposal of sewage sludge that the greatest improvements were possible, the President continued, and it was here also that they were most likely to be attempted in the near future. The increase in the world's population had made it necessary to increase enormously the food supply; inorganic fertilisers were only a palliative and the cure was said to be in the greater use of organic fertilisers and soil conditioners, and the return of all suitable sewage sludge to the soil would help in no small measure to conserve soil fertility. The keynote of future developments in sewage treatment was increase of efficiency in well-established processes and utilisation instead of mere disposal of sewage, especially of sewage sludge. The President also discussed the problems of industrial wastes and radio-active wastes.

Thirty Years' Development of Opposed-Piston Propelling Machinery*

By W. H. PURDIE, M.I.MECH.E.

No. I

IT is now just over thirty years since the first Doxford opposed-piston marine oil engine commenced trials on the test bed in Sunderland, and had the vessel into which this engine was fitted survived the 1939–45 war she would have completed thirty years' service in June, 1951. Much has been written about the Doxford engine in the technical press and elsewhere since 1921, and the general construction is very well known. I would like, therefore, to include in this lecture some of the lesser-known difficulties which were experienced and the methods which were adopted by the builders to reduce the dimensions and weight while attaining increased reliability, economy and ease of maintenance in service.

Before dealing with the Doxford marine oil engine, it may be worth while to record that whilst various forms of engine using pistons moving in opposite directions in an open-ended tube from a single combustion chamber have been patented during the last fifty years—the records are full of them—we must give credit to the Germans, Oechelhäuser and Junkers, for putting on the market commercial gas and oil engines with single crankshafts having three throws per cylinder unit, working on the two-cycle principle. Oechelhäuser gas engines were widely known in this country about fifty years ago for generating electric power and driving blowing tubes in steel works. Junkers' interest was mainly on the academic side and he was interested in oil fuel.

Single Cylinder Engine

In the autumn of 1912 Doxfords took out a sole licence for the manufacture of Junkers engines in this country. About six months were spent in considering various designs and, in May, 1913, came the construction of a single-cylinder engine of 500mm (19·7in) bore by 2 by 750mm stroke, designed to develop 450 b.h.p. continuously at 120 r.p.m. and to form a unit of a four-cylinder engine of 1800 b.h.p. Air injection of fuel was employed with the high injection pressure of 1400 lb to 1700 lb per square inch as compared with the more usual 900 lb to 1,000 lb used at that time with other types of diesel engines.

The outbreak of war in August, 1914, ended entirely our association with Professor Junkers before the experimental engine was running. In November-December, 1914, the engine made a continuous run of five weeks under the supervision of Lloyd's Register, whose Chief Engineer Surveyor, Dr. John T. Milton, kindly loaned three surveyors, who supervised the trials, taking eight-hour watches during the run, and collected data and prepared diagrams. The trials were carried out on Anglo-Mexican oil of about 0·91 gravity, containing about 3 per cent sulphur. This gave us our first taste of the trouble that sulphur can bring in its train. The exhaust noise from a large, single-cylinder engine in an industrial neighbourhood among working-class houses was objected to so strongly that in order to take the noise out of this barking engine we injected a considerable quantity of water into the exhaust pipe in the form of spray. It was noticed during the five weeks' trial that the exhaust noise was becoming slightly louder, and when the silencer was examined at the end of the thirty-five days only a small fraction of the original baffles remained. About half a ton of ½in thick steel plate had completely disappeared! The engine carried on with a mean indicated pressure of about 100 lb per square inch at 120 r.p.m. and an average fuel consumption of 0·43 lb per b.h.p. per hour was obtained. During the following year we started to boost the power up and we got up to 750 b.h.p., an overload of something like 66 per cent, running at 160 r.p.m. At times we got mean pressures up to 10 atmospheres on throttled exhaust.

At this early stage, when sea water cooling of jackets, covers and pistons was almost universal for marine oil engines—because there was plenty of it—the experimental Doxford engine jackets and pistons were cooled by distilled water in a closed circuit and the engine was preheated by circulating hot water before starting up. The underlying reason for this was that the firm were marine steam engineers. The engines were, therefore, preheated from the very start. We did not realise at the time the many advantages that preheating would give, such as the ease with which the engine would start, even in the coldest climatic conditions, the avoidance of corrosion in piston-ring grooves by keeping the temperature above the dew point of the sulphurous gases and the reduced quantity of heat dissipated to jackets and pistons due to the higher temperature. In many of the tests at the test bed with a single-cylinder engine we carried cooling water temperatures up to 200 deg. Fah., and this—in conjunction with higher mean pressures—did a great deal of useful work on the engine by eliminating any feature that was not proving reliable. The engine was built as an open engine. There were splash plates round the crankshaft, a small rotary pressure pump supplied oil to the bottom ends and main bearings, and the top ends were lubricated by small mechanical pumps fed by back-feed. These pumps were operated by the oscillation of the cross-head bearings.

Whilst we were running the engine at 160 r.p.m., 750 b.h.p., with pressure of nearly 1800 lb (we had a 20-ton flywheel, about 13ft in diameter), the compressor, of the vertical, three-stage, straight-line type, suddenly seized owing to a failure of lubrication to the high-pressure piston—which was made of steel and not of cast iron. The engine pulled up in two or three revolutions, bringing the engine out of the test bed, alarming the staff and removing nearly all the plaster out of the roof. However, the engine was not damaged in any way. This had a bearing on future progress, because within twenty-four hours the order came from Robert Doxford that there was to be no more air injection and we had to evolve another system. For years we called it solid injection, until people began to ask where we got our solid oil. Later on we called it airless injection, but I see that Mr. Pounder, when referring to another engine, asked why call it by the name of something it has not got!

The injection system adopted was similar to that evolved by Messrs. Vickers-Armstrongs, at Barrow, for "E"-class submarines. The fuel was forced at high pressure by pumps into the reservoir. We used a biggish volume of oil and relied on the bulk modulus of the fuel and the elasticity of the nozzle to give the necessary energy to inject the fuel. We knew very little as to the range of quantity that a given nozzle of fuel would pass. We had no experience, and we thought it would be necessary to bring in four fuel valves, one at a time—for the lowest load, one, with a little more power, a second, and then a third and a fourth. We soon found that this injection system gave very reliable running. It was quite controllable and we found further, that we could work with a considerable range of injection pressures—anything between 2000 to 3000 for slow running and with full power we were up as high as 10,000 lb per square inch. The single-cylinder engine would run steadily at 35 to 40 r.p.m. without any manipulation of controls. This slow speed running has always been a feature of the opposed-piston engine with this type of injection.

When dealing with this airless injection system we started off with a compression pressure of 40 atmospheres, which was what we were using with air injection and we soon found that to get good combustion with this system we had to bring the cams so far forward that the maximum pressure went right off the scale, so the first thing was gradually to reduce the length of the piston rods and so alter the compression pressure. We found that about 280 lb per square inch compression pressure (20 atmospheres) gave us the best result with that particular engine and with a maximum pressure of about 40 atmospheres we came down to a consumption of 0·42 lb per b.h.p. per hour. There were certain small initial troubles, such as the substitution of hardened and ground pump rams and needle valves for the glanded needles, which very soon ran hot, but the system proved reliable and controllable at all speeds and powers.

For the most part the running had been done on Anglo-American fuel oil of about 0·91 specific gravity, but on one occasion, owing to an accident, we received a tank of furnace oil of 0·95 gravity and perhaps this was the very first occasion on which boiler oil was burned in a diesel engine with airless injection. The results were queer, but we were accustomed to queer results in those days!

Four-Cylinder Engines

While these experiments were being carried on work was steadily proceeding on the design of a four-cylinder engine of 580mm (about 23in diameter) by 2 by 1160mm stroke, designed to develop 3000 i.h.p. on trial at 77 r.p.m., about 68 to 70 service revolutions with a loaded ship. The horse-power per cylinder was greater and the revolutions were lower than in any contemporary oil engine in service or design at that time for sea-going vessels. We had the modern steam engine background and we thought in terms of 68 to 70 revolutions.

At this stage experimental work had cost the firm about £100,000, which is not a big sum in these modern days, when you have research associations supported by collective industries, but in 1914 it was a considerable outlay for a single firm of modest size, who were in fact playing a very lone hand. It says much for the courage of the directors that a few months after permission had been granted by the Admiralty to pro-

* Institution of Mechanical Engineers. Twenty-third Thomas Lowe Gray Lecture. Extracts.

ceed with the first engine in the autumn of 1918, just before the Armistice, we embarked on the construction of three more engines of similar size, while the first was just beginning to take shape. Such was their confidence in the designer—Karl Otto Keller—who had been in charge of all experimental work on the oil engine from 1910. He was chief draughtsman and designer until 1918 and then engineer manager until his death. He became a director in 1937. His sudden death in 1942 robbed the firm and the country of the services of a great engineer, who had done much to put British motor shipping where it is to-day.

In October, 1920, the first engine was completed and started up on the test bed. After prolonged shop trials it was installed in M.V. "Yngaren," built for the Swedish Transatlantic Company, of Gothenburg. Sea trials took place in June, 1921.

This vessel left Sunderland in June, 1921, immediately after sea trials, but she was not finished at that time. There was a strike of ship joiners and she was completed in Gothenburg in about October, 1921. She then left for a maiden voyage to Australia via Suez and Surabaya and there were no incidents. She loaded at Melbourne and ran home to Dunkirk—nearly 12,000 sea miles—in forty-two days, with stops of about eleven hours, mainly for the high-pressure fuel system. The power was steady at 3000 i.h.p. at 75 r.p.m.—the sea trial conditions—at least 10 per cent higher than we had intended in use. The chief engineer said that if he could have twenty-four hours to look over his fuel valves and pumps he would be ready to do the voyage all over again!

But there were difficulties, and one of the first came from an unexpected quarter. We were cooling the jackets and pistons with distilled water and in our ignorance or simplicity we thought distilled water could not corrode anything. We had it in our boilers and we thought it was all right. We did not realise that there is a vast difference between an oil engine circulation going at a high rate with only a small quantity of water in the system and therefore going round the system every two or three minutes (and open inspection hoppers entraining a great amount of air) as compared with water going round the circuit of the boiler, condenser and so on in a matter of hours. In one round trip to Australia we had very severe corrosion on the swinging links and arms and we had not had similar trouble with the experimental engine. We could only attribute it to the time on the test bed being much shorter.

Various remedies were considered to overcome the trouble and by a lucky discovery of our works chemist—the late Ernest Armstrong—we found that by mixing ordinary bichromate of potash with the cooling water we could render the surface of the iron pistons and jackets passive to the attacks of the oxygen. There was only one drawback, which is quite important. If you have potassium dichromate and sea water you get a very corrosive mixture. Therefore we kept the jacket and piston motor cooling pressures always higher than the sea water on the other side of the tubes and so avoided that little trouble.

While the M.V. "Yngaren" was at sea we were very busy with the second engine. In order to cut down some of the liner wear we used a very hard cast iron, practically a white iron, obtained on the Clyde. The turning, milling, drilling and boring were a very severe test of machine-shop equipment because there was no tungsten carbide available in 1921. We started up the second engine on the test bed in September, 1921, and after a few hours one cylinder went off with a crack in the centre of the combustion chamber. It was replaced with a spare and that one went as well, so we decided to wreck the lot and carried on until we had cracked them all. We got gusts of exhaust gas from cooling-water hoppers and had mean pressures in some of the liners up to about 140 lb per square inch.

New liners were put in hand of normal cylinder iron, and as an experiment the scavenge ports were made tangential. We had no idea how much tangent was required so we put about 12in to 14in and gave a really good swirl. Tangential ports had been considered in 1916 to avoid interference when truly radial ports were used. We started up the engine and as soon as the speed went up the engine misfired. The engine would start and run at low speed without difficulty but if more fuel were given the speed would increase up to about 100 r.p.m., the engine would then commence to misfire, slow right back to 40 r.p.m and then repeat the performance. The cause of this erratic behaviour was that the high swirling velocity carried the separate streams of fuel from the jets into a common column, which would not ignite in the time available. When we used a slightly different type of spray we did not have this difficulty. These things are quite amusing to think about afterwards but they are not so good when you do not know the reason for them!

The second engine performed quite well until it had been in service about six months. Then we got surface cracking all over the combustion chamber and the liners had to be changed. This was due to the very intense swirl, which causes combustion to take place most fiercely near the walls of the cylinders, even with modern engines. In some experiments made in 1949 we found how intense is the gas temperature near the cylinder walls with swirling combustion. Our troubles with cracking gave us the idea that you could put the fuel valves in line and make piston tops hemispherical, instead of flat-topped, to produce an almost ideal combustion chamber.

(To be continued)

Electrical Engineering in 1950

No. IV—*(Continued from page 103, January 19th)*

Alphasil Cold Reduced Transformer Sheet

THE attractive prospect of low-loss anisotropic sheet being made readily available to British transformer manufacturers was brought nearer during 1950 when Richard Thomas and Baldwins, Ltd., began production, on a small scale, of cold reduced strip. This development represents the result of several years' research work, which, unfortunately, had to be interrupted during the recent war. However, the progress made since the development programme was resumed in 1946 has enabled the company to make available supplies of the new transformer core material, known as Alphasil, in the form of annealed strip, in flat lengths up to 18in wide, or of cut and punched transformer laminations ready for assembly. Further, preparations for the supply of the new material in bulk are in an advanced state.

In the meantime the company has studied the characteristics of Alphasil in comparison with the hot rolled sheets in general use hitherto. The results of this investigation are contained in a report on the performance of power transformer cores of conventional design, built from various grades of transformer sheets made by Richard Thomas and Baldwins, Ltd., Wilden Iron Works, Stourport on Severn. For the purpose of this investigation a series of transformer cores were made up to the same dimensions and the same magnetising coil with the same applied voltage was used for each core, to give the same nominal value of B-max. throughout the tests. The results proved the anisotropic grades to have much lower values of watts loss than the best hot rolled sheets, notwithstanding the fact that the cores were of conventional design and that the flux path was not, therefore, in the preferred direction throughout its entire length. A comparison of the hot rolled sheets with the cold reduced anisotropic (Alphasil) material, comprising the company's present manufacturing programme, is tabulated herewith. The losses quoted are the maximum total values due to the combined effects of hysteresis and eddy currents at 50 c/s; normally the materials are tested and guaranteed at B_{max}=13,000 grams.

Losses in Transformer Grades of Electrical Sheets

Quality	Watts loss per pound		
	B=10,000	B=13,000	B=15,000
Q4. Hot Rolled ...	0·63	1·07	1·54
Q5. Hot Rolled ...	0·59	1·00	1·44
Q6. Hot Rolled ...	0·54	0·92	1·34
Q7. Hot Rolled ...	0·49	0·86	1·24
Q8. Hot Rolled ...	0·45	0·80	1·15
Alphasil 77	0·50	0·77	1·02
Alphasil 66	0·37	0·66	0·91
Alphasil 55	0·31	0·55	0·76

Transformers

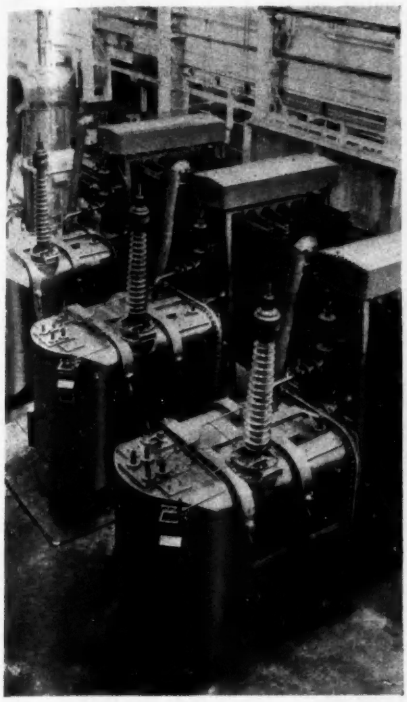
Among the interesting transformers exported during the year was the first of five being built by Ferranti, Ltd., for installation at the Pyhakoski power station of the Imatra Power Company, Finland. The transformer, which was described in our issue of December 22nd, is a three-phase unit with three windings, which are rated, respectively, at 64/64/32MVA, the voltage ratios being 115·5/231/10·5kV between phases. Both of the higher voltage windings are star connected, with the neutral ends fully insulated, while the 32MVA, 10·5kV winding is intended to supply three 10MVA reactors to compensate for the capacitive load of the 220kV transmission lines. To meet the customer's potential test requirements the 231kV windings were designed for and tested at 530kV, 50 c/s. The corresponding power-frequency test voltage applied to the 115·5kV windings was 275kV.

Cooling of this transformer is by forced oil circulation with two banks of air-blast-cooled radiators adjacent to the transformer itself. The oil flow is positively directed from a distribution chamber into the axial ducts of each winding in predetermined proportions. Baffles are arranged in the axial ducts to make the oil flow alternately outwards and inwards through the succession of radial winding ducts. As a

result of this system of directed flow, the difference between the mean and maximum oil temperatures in the tank is stated to be only 2 deg. or 3 deg. Cent. at full load.

Because the lifting capacity at the Finnish port of Abo is limited to 90 tons the core and windings of the transformer were dispatched for transport in a special light tank, while the service tank, service cover, bushings and radiators were shipped separately.

One of the accompanying illustrations



THREE 15MVA SINGLE-PHASE TRANSFORMERS FOR AUSTRALIA

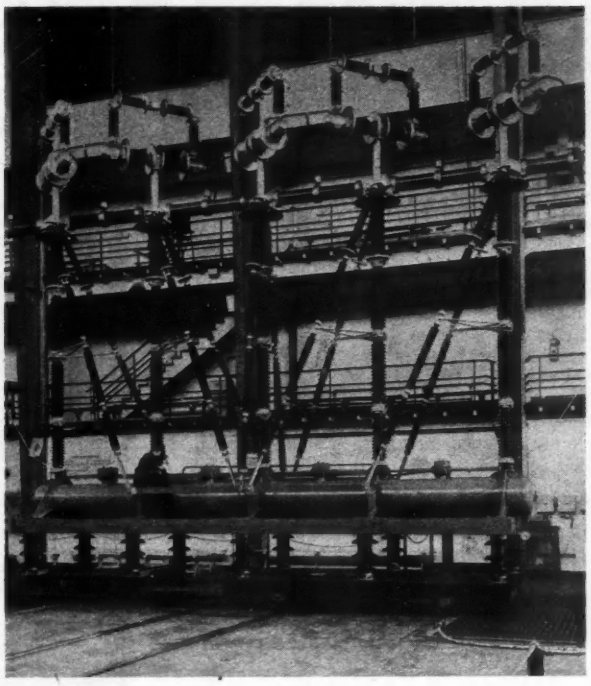
shows three 15MVA single-phase B.T.H. transformers, which will form a 45MVA, 210/120/22kV, three-phase bank for the State Electricity Commission of Victoria, Australia. An interesting point about these transformers is that they have shielded concentric cylindrical layer windings. The layer-type high-voltage windings are not varnish treated but are oil impregnated under vacuum in the vacuum vessel, which is now in regular use in the new heavy plant factory at the British Thomson-Houston Company's Rugby works.

AIR-BLAST CIRCUIT BREAKERS

Recent progress in the design of air-blast circuit breakers for very high voltages was typified by two demonstrations that we were invited to witness during 1950. The first of these demonstrations was given at the Baden works of Brown Boveri and Co., Ltd., where tests were carried out on specimens of a new range of air-blast circuit breakers, as described in our issue of November 10th, page 441. An arc extinction chamber of new design forms a common component in all the members of the range, the number of arcing chambers in series depending on the rating of the circuit breaker.

One of the photographs reproduced on this page shows a single-phase of the largest circuit breaker in this range. Three similar units arranged as a three-phase circuit breaker have a rupturing capacity of 8600MVA at a maximum service voltage of 400kV. The unit illustrated is typical of equipment being supplied for the Swedish 380kV system. The single-phase unit consists essentially of five pairs of arc extinction chambers mounted on an insulator structure, embodying a system of stays, which are so disposed that their members are stressed in tension only. Viewed from above, the arcing chambers are disposed in zig-zag formation at 45 deg. to the main longitudinal axis of the circuit breaker. Arranged horizontally below the chambers are the control capacitors, whose function is to improve the voltage distribution across the series breaks. Our illustration shows the specially shaped electrodes, which are designed to eliminate brush discharges.

On November 2nd we attended a demonstration of outdoor air-blast circuit breakers manufactured by the English Electric Company, Ltd., Stafford. The tests (which were referred to in our issue of November 17th, page 472) were vividly presented with the help of Marconi television transmitters, and a number of receivers set up in an observation room in the Nelson Research Laboratories, overlooking the test area. Viewers were thereby given close-up shots of the circuit breakers in operation and of oscillographic records and explanatory diagrams displayed in the operations room, from which the programme of tests was controlled. The whole display gave a good illustration of the possibilities of television as an industrial aid.

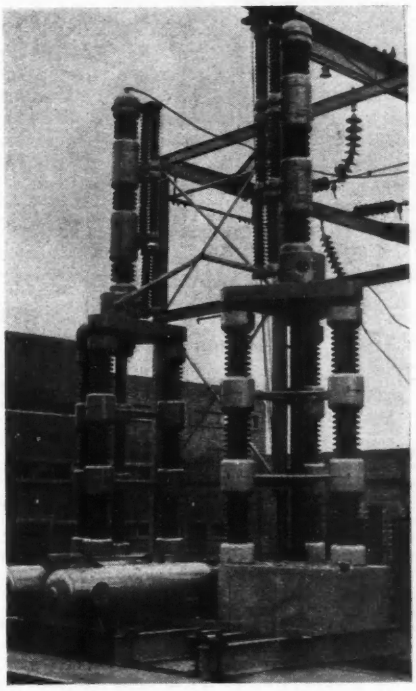


SINGLE-PHASE UNIT OF 380KV CIRCUIT BREAKER

Four circuit breakers with the following ratings respectively, 2500MVA at 132kV, 3500MVA at 165kV, 7500MVA at 275kV and 10,000MVA at 400kV, were demonstrated. A standard interrupter unit forms a common element in the range, the number of series breaks depending on the rating. Thus the four equipments referred to above have respectively two, three, six and eight interrupters per phase.

A single phase of the 275kV breaker, as illustrated, consists of two identical halves, each of which embodies an air receiver and three interrupters in series. The two halves are joined electrically by a double-blade make-switch, which connects the six interrupters in series, to form one complete pole of the circuit breaker. The interrupters and make-switch driving equipment are supported on an insulated base built up of easily handled porcelain elements, assembled in tripod formation, the three legs being stayed together at the top casting and at two intermediate points to constitute a stable structure. Use is made of the hollow tripod legs to enclose the auxiliary switch mechanical drives and to convey air to the make-switch operating cylinders. In addition there is a central insulating column of larger internal diameter, which carries the main air required for circuit interruption.

The local air receivers consist of two forged drawn drums per pole and are mounted at the base of the circuit breaker between the two sets of tripods. Being independent of the interrupter columns, the receivers are readily accessible for inspection. The main blast valves are fitted on the sides of the receivers at the base of the main air column, where they can be dismantled without disturbing any insulators. High-speed electrically operated pneumatic valves control



ONE POLE OF A 275KV, 7500MVA AIR-BLAST CIRCUIT BREAKER

the blast valves and, on opening, admit high-pressure air, via the central insulator posts, to the interrupters. Air passages are provided to distribute a portion of the air to

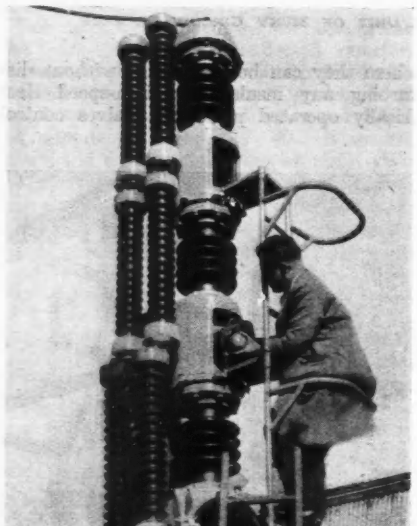
each interrupter, forcing the moving contacts down and drawing an arc in each interrupter throat. The arcs are extinguished by the cooling and scavenging effects of the compressed air, which carries the arc products with it into the coolers. In each interrupter there is a special arcing probe to carry the arc, during the short period that it persists and, thus, to protect the current-carrying surfaces.

Of the photographs reproduced herewith one shows a single phase of the 275kV circuit breaker, while another shows the operation of removing the interrupter contacts.

Loch Sloy Control Room

Loch Sloy power station, which was opened by Her Majesty the Queen on October 18th, embodies a good example of modern practice in remote control. The control equipment at Loch Sloy is claimed to be the first of its kind in the world, all the essential controls of the generators and circuit breakers being grouped and centralised within reach of one engineer.

The installation, which is illustrated herewith, comprises a generator control desk and a floor mounting mimic diagram, which together provide full facilities for the metering, indication and control of four 32MW turbo-alternators and six 132kV feeders. The system used is the "miniature direct wire remote control," which was developed, manufactured and installed by Standard Telephones and Cables, Ltd. It makes use of automatic telephone apparatus and wiring to operate interposing relays on

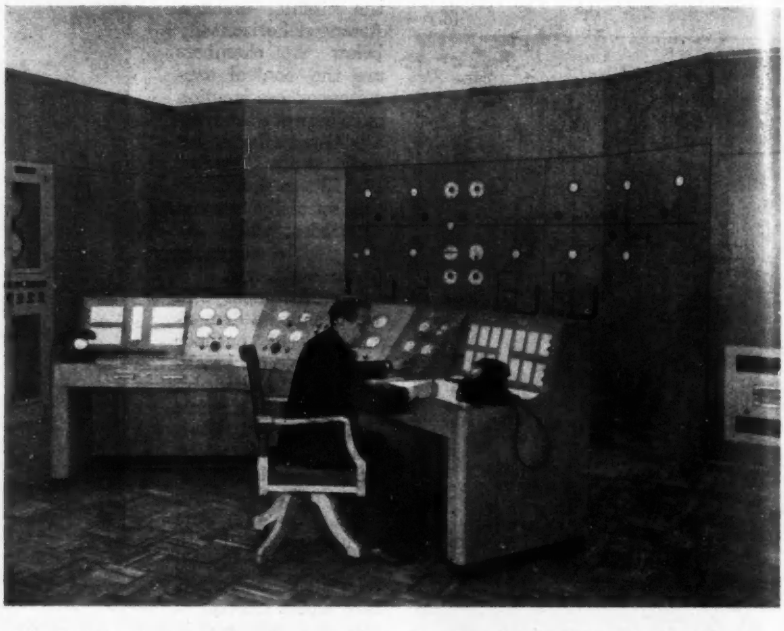


Contact Changing on 275kV Air-Blast Circuit Breaker

the turbine or switchgear panels, which, in turn, control the circuits of the normal "trip" and "close" coils, &c. Up to and including the interposing relays the system operates at 50V d.c. and the small operating currents are easily carried by single 0·036in cable, weighing only 20 lb per mile.

The control desk accommodates four generator control panels, two alarm display panels and a twenty-line cordless private branch telephone exchange. On the desk itself the controls consist of telephone type keys with 1in diameter knobs. Each generator panel carries speed and voltage control keys, one generator circuit breaker control key and four 4in diameter indicating meters, giving readings of megawatts, power factor, rotor volts, rotor amperes. The engineer therefore has full control over the four generators; he can synchronise (reading the synchronising instruments on the mimic diagram), adjust load, and carry out switching without leaving the desk.

To ensure that indication of any abnormality is immediately communicated to the control engineer, all the turbine, generator and switchgear protective devices are continuously monitored by a direct-wire alarm system. Alarm display panels are accommodated in the wings of the desk. The panel on the left of the operator displays, in groups, seventeen alarms for each of the four generators and there is a fifth group for miscellaneous alarms. On the right-hand panel six alarms are grouped for each of the feeders and twelve alarms for the bus section and line protection. Each alarm display lamp is wired via a relay to the alarm originating contacts on the associated protective device; on the occurrence of an abnormality the appropriate lamp flashes and an alarm bell rings. The "alarm accept" key for the group is then pressed to silence the bell and steady the lamp.



Miniature Direct Wire Remote Control Desk—Loch Sloy Power Station

On the mimic diagram are shown the electrical arrangements of the station and the water and oil systems of the turbines. Circuit breakers and isolators are indicated by three-colour, single-aspect lamp indicators. The control keys for feeder and bus section circuit breakers are placed next to the appropriate indicators. There are six 6in meters mounted on the central panel of the wall diagram, to indicate megawatts, megavars, frequency, incoming volts and busbar volts, the sixth instrument being a synchroscope.

Gas Turbines in 1950

No. III—(*Continued from page 94, January 19th*)

Continental Gas Turbines

In Plate 12 of our January 12th issue we reproduced two recent photographs of the new standby thermal power stations of the North-East Switzerland Power Company at Beznau and Weinfelden. These illustrations are of particular interest, as they show in detail the very generous lay-out and arrangement of these two important gas turbine plants. Unfortunately, as we stated last week, the titles of the two blocks were transposed. It is the upper view which shows the 20MW Sulzer gas turbine driven alternator set at Weinfelden. In the lower view, the Brown Boveri 13MW and 27MW gas turbine driven generating sets at Beznau are shown.

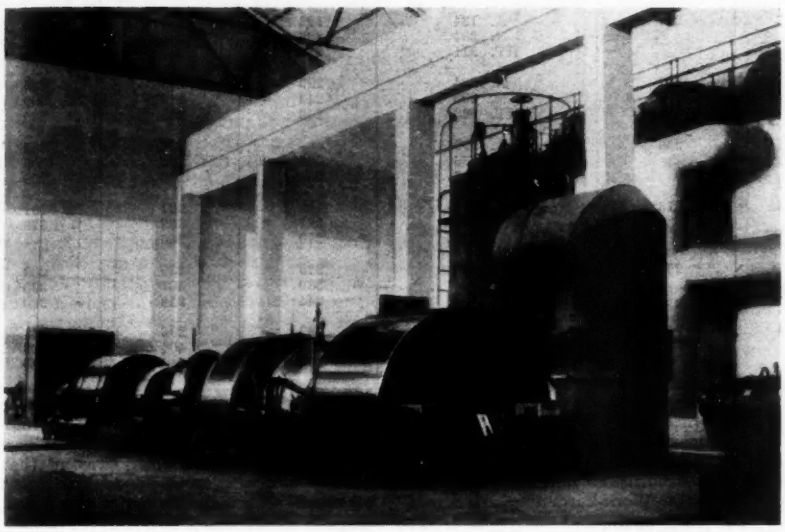
Brown Boveri and Co., Ltd., Baden

Last autumn we were invited to visit the Beznau power station, which at that time was undergoing a routine overhaul before starting up on the winter load. As the turbines and compressors were partially dismantled, we were able to see the excellent state of the turbine blading and nozzles. We noted, too, the evident care which had been bestowed upon the design and lay-out of gas turbine and compressor units, the ducting for the heat exchangers, and the exhaust gas outlets. Arrangements have been made to allow for and, in some instances, to indicate visually the expansion of piping and machines which takes place when running under load conditions. Attention has also been paid to the question of ensuring a supply of clean air for combustion, and an extensive air filtering plant has been installed. The capacity of the fuel tank installation allows the plant to be run at full load over long periods.

In the lower engraving on Plate 12, already referred to, the 13MW set is seen in the foreground and the 27MW set is in the background. It is of interest to record that by November 3rd last the total

energy supplied by the two gas turbine generator sets reached 100,000,000kWh. Throughout the months of October and November last year the sets ran uninterruptedly each week from Monday morning until Saturday noon. Since that time, however, the heavy rainfall in Switzerland has so increased the stored-up water for the hydro-electric stations that it seems unlikely that the thermal plants will be required to run again during the winter months.

Another interesting plant constructed by Brown Boveri and Co., Ltd., briefly referred to on page 50, was that supplied for the C.A. Venezolana de Cementos, of Pertigelete, in Venezuela. It comprises two 1650kW gas turbine driven alternators which were installed, and came into operation, at the beginning of 1950. They have been designed to meet the cement factory load of 1MW and



1650kW Brown Boveri Gas Turbine in Venezuela Cement Works

to run constantly, one acting as a standby plant. Each set has now a running record of some 5000 hours. The accompanying engraving shows the second set, taken from the gas turbine end. In the background to the right will be seen three of the four heat exchangers belonging to each unit. At the extreme right the exciter of the first set will be seen. The owners of this cement plant have recently decided to treble its capacity and for this purpose a 5MW gas turbine generating plant of similar design and arrangement to the two units already installed has been ordered from Brown Boveri and Co., Ltd. It is expected to be delivered and erected in the early part of 1952. In view of the very satisfactory running experience gained with the many plants now in commercial operation, Brown Boveri and Co., Ltd., has decided to take an active part again in the gas turbine business. At the present time the total number of gas turbine plants ordered from the firm and exclusively intended for driving alternators is fourteen. The total power amounts to 95MW.

Sulzer Brothers, Winterthur

The 20MW gas turbine unit operating on the Sulzer high-pressure cycle and driving a 25MVA three-phase alternator at 7300V to 8300V, was completed, and ran for the first time in the early months of last year. During 1950 the station was in operation about 1500 hours at increasing loads. Towards the end of the year 15MW was approached. We paid a visit to Weinfelden during the autumn while the plant was being prepared for the winter run. The arrangement, we may recall, consists of three sets of gas turbines, a feed set with a gas turbine driven compressor, taking air from the atmosphere; a circuit set, comprising an air turbine with medium and high-pressure compressors, and an output set consisting of a gas turbine driven alternator. The third unit is to be seen to the right of the upper view on Plate 12 of Jan. 12th issue, together with a turbine rotor near the alternator, prior to its assembly. The well-lagged communicating pipes may be noted, and in the background can be seen the combustion chamber and the air heater and secondary combustion chamber, the intermediate recuperators and coolers. The main recuperators and coolers are grouped in the basement below the turbine room, while auxiliary recuperators are fitted in the exhaust gas discharge ducts. Great care has been taken to separate the air intakes and the exhaust discharge ducts so that, when burning sulphurous fuels, no sulphur oxide emissions will be taken into the air circuit.

The excellent duct work was noted in this station, and the careful manner in which expansion is allowed for. When complete trials have been made we hope to give a fuller account of this plant. During the period under review the Weinfelden plant received main attention but it is approaching completion and it is expected that work will again be resumed on the 7000 h.p. marine gas turbine, which has already made several runs.

Escher Wyss, Zurich

The main activity of 1950 at the Escher Wyss Engineering Works at Zürich was concerned with the completion of the 12·5MW gas turbine generator set for the St. Denis power station, Paris, of Eléctricité de France. Its erection was completed towards the end of the year, and it is expected that the trials of this interesting plant will shortly begin.

The original test unit in the makers' works has an output of 2000kW; it is supplying current to the town mains and already has 6000 hours of running service to its credit. During the year Dr. Kurt Keller, director of the firm's research and development department, paid a visit to America in order to further the development of the Ackeret-Keller closed-cycle system of gas turbine construction in the United States.

Maschinenfabrik Oerlikon, Zurich-Oerlikon

At the works of Maschinenfabrik Oerlikon, of Zürich-Oerlikon, further tests were made during the year with the 1000kW test bed unit, which for three winters has been connected to the town mains and has run for over 6000 hours. For 1000 hours bunker fuel oil was used and about a hundred hours were run with tar from German brown coal. Throughout these tests no difficulties were met with. Towards the end of the year Dr.-Ing. W. Karrer gave a lecture in the Haus der Technik at Essen, in which he dealt with the place of the gas turbine in the range of modern prime movers. He stressed the use of gas turbines in association with back-pressure steam turbines, and with condensing steam turbines in power stations. Using the results of his own work in connection with a test boiler fired with the exhaust from the gas turbine, he showed conclusively the gain in overall efficiency which is possible by combining gas turbine driven and steam-driven plants.

Netherlands Developments

In 1950 many parts of the prototype gas turbine unit which is being constructed by a group of Dutch firms, including Stork Brothers, Werkspoor, the Royal De Schelde Shipbuilding Company, Wilton-Fijenoord, N.V., and the Rotterdam Dry Dock Co., were completed, and it is expected that final erection of the turbine and compressors will soon take place. The turbine will provide experience for the future development of both industrial and marine gas turbines.

Japan

It is interesting to note that the Japanese have turned their attention to the building of gas turbines and a machine was constructed by the Ishikawajima Shibaura Turbine Company, Ltd., for the Research Institute of the Japanese Ministry of Transportation. This is a single-shaft set of 2200 h.p. and intended for investigating its possibilities for locomotive work. The machine was designed with four impulse stages in the turbine and twenty reaction stages in the compressor, and there are two combustion chambers, one on each side, the design of which is being further considered. An estimated efficiency of 13 per cent is expected at full load with an inlet temperature of 650 deg. Cent., but, owing to doubts concerning the suitability of the alloy steels used, trials were not run at this temperature.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 24, Victoria Street, London, S.W.1.

INDUSTRIAL SAFETY GLOVES

No. 1651 : 1950. This standard deals with safety gloves, mittens and hand guards for protection against common hazards in all industries. It is based on practical trials lasting several years and is designed to canalise the demand for safety gloves from more than two hundred different types now commonly supplied, each type in several sizes, into a range of seventeen preferred types, each supplied in a minimum range of sizes. This standardisation will facilitate economic production as well as the ordering and stocking of safety gloves. The gloves specified are designed to provide adequate protection, and to overcome weak points existing in the past and thus to provide the greatest possible economy in use.

The gloves fall into five groups: leather, plastics, rubber, felt and cotton. The standard includes a list of hazards and recommends the appropriate types of gloves for each hazard. Requirements are given for materials, sizes, manufactures and methods of test; recommendations on the storage and preservation of rubber gloves are included, and a note on the information to be given when ordering gloves. Price 4s.

Metallurgical Topics

Cold-Working of Steel

SEVERAL reports of committees of the Verein Deutscher Eisenhüttenleute, dealing with cold-working operations and with the properties of cold-worked steels, were published in *Stahl und Eisen* for December 7, 1950. A paper by W. Reichel[1] (from the Committee for Bright-drawn Steel Bars) on the "Measurement of Temperature in the Drawing of Bars and Wire," described the method of making use of the couple formed by the die and the material drawn in measuring temperature, and showed the dependence of the drawing temperature on the shape of dies, drawing speeds, lubrication, &c. Just as in machining there are supercritical speeds at which the temperature developed starts to fall with increasing cutting rate, so also there are supercritical speeds in rod and wire-drawing. It was suggested that the study of supercritical drawing speeds by the aid of the temperature-measuring procedure outlined in the paper would have useful practical applications, and might lead to technical developments in drawbench design.

A second paper, issued by the Committee for Bright-drawn Steel Bars, was by H. Bühler and E. H. Schulz,[2] and dealt with "The Reduction of Internal Stresses in Bars which are being Cold-Drawn." It shows the effect of a finishing pass giving a very slight reduction in diameter on the magnitude and distribution of internal stress in both steel and brass. A final draw, giving a reduction in diameter of 0·4–0·8 per cent, was found to reduce the principal internal stress by 70–90 per cent. It is stated that the method may be applied without difficulty to rods of 20mm diameter and upwards. The properties of the rods are in no way adversely affected and the method is regarded by the authors as technically and economically superior to stress relief by heating. In spite of this it would seem that a more uniform control is likely to be attained by a stress-relieving heat-treatment and also a more effective removal of stress without serious effect on the mechanical properties, provided that the temperature employed reaches 500 deg. Cent. The following values are taken from a diagram, given in the paper, referring to a 0·18 per cent carbon steel, cold-drawn from 50mm to 48mm diameter :—

	Longitudinal internal stress tons per square inch	Brinell Hardness Number
As drawn	38·0	155
After heating at 400 deg. Cent.	21·0	158
After heating at 500 deg. Cent.	2·5	145

"A New Method of Measuring Drawing Dies" is described by C. Eisenhuth[3] in a report of the Committee for Wire and Wire Products. The apparatus, consisting of a slender conical needle attached to a graduated cylindrical holder, may be used for measuring the bearing length of wire-drawing dies.

Two reports of the Cold Rolling Committee follow. One of these, by V. Seul and R. Mintrop,[4] contains a full description of the process of electrolytically tinning cold-rolled strip, including a microscopical study of the surface condition of the cold-rolled material and the surface finish of the tinned strip, especially as affected by fusion of the coating. The other report of this Committee, by G. Niebch and A. Pomp,[5] on the "Influence of Different Heat-treatments and Alloying Constituents on the Work-hardening of Steel," describes an investigation, which it may be of interest to review in more detail.

[1] *Stahl und Eisen*, December 7, 1950, vol. 70, page 1141.
[2] *Idem*, page 1147.
[3] *Idem*, page 1153.
[4] *Idem*, page 1154.
[5] *Idem*, page 1166.

TABLE I—*Composition and Temperatures of Treatment*

Steel No.	Chemical composition, per cent C	Si	Mn	Cr	Mo	V	Annealing or quenching temperature, deg. Cent.	Tempering temperature, deg. Cent.
1	0·46	0·40	0·73	0·15	—	—	780	700
2	0·32	0·33	1·33	0·13	—	—	780	700
3	0·39	0·38	1·54	0·14	—	0·15	800	680
4	0·36	1·30	1·22	0·06	—	—	820	720
5	0·35	0·24	0·71	1·12	—	—	800	700
6	0·35	0·54	1·02	1·05	0·09	—	800	720
7	0·47	0·27	0·72	0·95	0·08	0·12	800	720
8	0·26	0·40	0·70	2·28	—	0·16	820	740

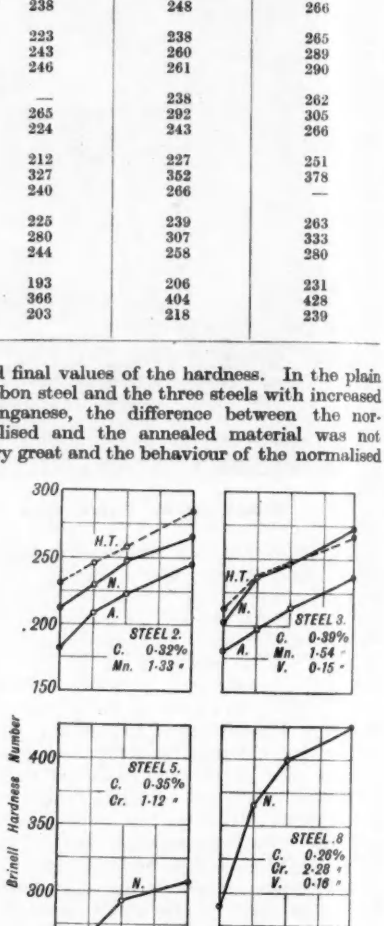
Other constituents : P under 0·025, S under 0·020, Ni 0·05—0·17, Mo and V (when not given) under 0·05 per cent.

WORK-HARDENING OF LOW-ALLOY STEELS

A plain carbon steel and seven low-alloy steels, containing various amounts of manganese, silicon, chromium or vanadium (Table I), in the annealed, normalised and quenched and tempered conditions, were cold-rolled to 10, 20 and 40 per cent reduction in thickness, and the degree of work-hardening thus produced was determined by Brinell tests. For the preliminary treatment three pieces of strip, 8mm thick and 45mm wide, from each steel, were heated for thirty minutes at the annealing temperature given in Table I. One piece was quenched in water and subsequently tempered at 20 or 30 degrees below Ac_1; another piece was cooled in still air and the third slowly cooled in the furnace. The hardness after cold working is shown in Table II. In any particular steel the preliminary treatment exercised a considerable influence on work-hardening. In the annealed condition all the steels showed a low initial hardness and a smaller degree of work-hardening than in the normalised or quenched and tempered condition. Moreover, the difference between different steels was not very great. In the normalised condition, however, there were considerable differences, both in the initial and final values of the hardness. In the plain carbon steel and the three steels with increased manganese, the difference between the normalised and the annealed material was not very great and the behaviour of the normalised steel tended to coincide with that of the quenched and tempered steel. In the four chromium-bearing steels, on the other hand, the quenched and tempered steels behaved more like the annealed steels, and the differences

TABLE II—*Brinell Hardness (5mm/750kg/30 sec.) of the Steels after Hot-Rolling, Preliminary Treatment and Cold Working.*
A = Annealed. N = Normalised. HT. = Hardened and Tempered.

Steel No.	Brinell Hardness Number Hot-Rolled	Treated	Cold-rolled, per cent 10	20	40
1	190	A. 191	197	214	230
		N. 207	223	240	259
		HT. 221	227	233	261
2	201	A. 184	211	223	245
		N. 209	230	248	265
		HT. 231	247	261	285
3	277	A. 184	194	213	239
		N. 204	236	246	268
		HT. 211	238	248	266
4	221	A. 204	223	238	265
		N. 208	243	260	289
		HT. 226	246	261	290
5	259	A. 209	—	238	262
		N. 236	265	292	305
		HT. 217	224	243	266
6	313	A. 207	212	227	251
		N. 266	327	352	378
		HT. 225	240	266	—
7	299	A. 204	225	239	263
		N. 224	280	307	333
		HT. 222	244	258	280
8	341	A. 163	193	206	231
		N. 288	366	404	428
		HT. 183	203	218	239



A. = Annealed. N. = Normalised. HT. = Hardened and Tempered.

FIG. 1—*Work-Hardening of Cold-Rolled Steels (Niebch and Pomp).*

between them and the normalised steels was much greater. Typical examples are shown in Fig. 1 (p. 136). Chromium had a far greater effect than the other alloy additions, not only on the initial hardness but also on the degree of work-hardening of the normalised steel.

The hardness ranges obtainable with the three conditions of preliminary treatment in general overlapped, but in some steels there is a gap in the hardness range: for example, no convenient amount of cold work will give a hardness between about 240 and 360 in Steel 8 (Fig. 1). To obtain a hardness of 300 in a cold pressing of this material, it would be necessary to apply a lower tempering temperature to the quenched material or, preferably, to substitute controlled cooling for air cooling from the normalising temperature.

The varying behaviour associated with differences of composition and preliminary treatment opens up a series of possibilities for influencing the processing of these materials by cold working. Some of these are discussed by the authors, who point out that a composition and condition of steel showing slight work-hardening is most suitable for tubes, sheets, stamped and deep-drawn parts, in making which extensive deformation without intermediate annealing is desired. On the other hand, the strongest possible work-hardening effect may be sought: for example, in the production of strengthening ribs in a semi-finished product. Alternatively, a combination of the two may be desirable, a slight work-hardening in the principal shaping operation and a more powerful work-hardening to produce greater strength and hardness locally in some part of the pressing by a slight supplementary deformation. Such a combination, the authors suggest, could be achieved by the use of chromium steels, the first pressing operation being carried out on the annealed material. The semi-finished parts could then be heated to the normalising temperature and cooled either in air or at a controlled rate on a conveyor belt passing through the furnace; and the final pressing operation, designed to confer high local strength, carried out on the material so treated.

Brittle Fracture of Pearlitic Steels

Difficulties are encountered from time to time owing to the brittle fracture of pearlitic steels, especially at low temperatures; much work has been carried out in an endeavour to improve their low-temperature ductility.

A study has been made by J. A. Rinebolt and W. J. Harris, jun., of the "Effect of Alloying Elements on Notch Toughness of Pearlitic Steels."[1] The steels were made in melts of

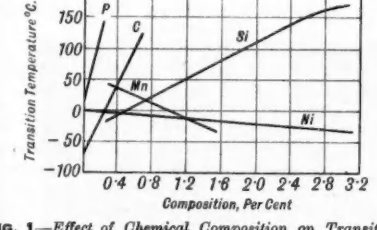


Fig. 1—*Effect of Chemical Composition on Transition Temperature (Rinebolt and Harris)*

about 250 lb in a high-frequency furnace and cast into four or five ingots of about 55 lb each. The first ingot poured was made to a basic composition, usually carbon 0·3 per cent, manganese 1·0 per cent and silicon 0·3 per cent, except when the influence of one of these elements was being investigated. Successive alloy additions were then made to cover the range of compositions required before each of the other ingots was cast. From the 4in by 4in by 18in ingots blanks (4in by 4in by 1½in) were sawn, heated at 1260 deg. Cent. for one hour and forged down to ⅝in square bars. They were normalised by holding at 900 deg. Cent. for one hour and cooling in air. The Charpy and tensile blanks cut from them were heated for four hours at 900 deg. Cent. and cooled at the rate of about 14 deg. Cent. per minute between 900 deg. and 425 deg. Cent. This gave a uniform coarse pearlitic structure in all the alloys investigated. Some steels with the higher alloy additions were given a further tempering for four hours at 485 deg. Cent. and then cooled at the rate of about 14 deg. Cent. per minute to reduce their hardness without seriously affecting their structure. Impact tests were made with Charpy vee-notch specimens at temperatures between +315 deg. and −190 deg. Cent. From the impact value/temperature curves transition temperatures

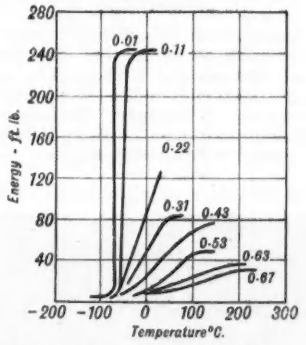


Fig. 2—*Effect of Carbon on the Shape of the Transition Curve (Rinebolt and Harris)*

were determined. Owing to the form of the curves the actual value of the temperature of transition from tough to brittle fracture depends on the definition adopted, but whatever the definition the relative effect of alloy additions was approximately the same. In this work the temperature at which the energy absorbed was halfway between the maximum and the minimum energy was taken as the transition temperature.

The desirable additions were those which would decrease the transition temperature, but the addition of most elements led to the opposite effect. Carbon, chromium, copper, molybdenum, phosphorus and silicon were found to increase the transition temperature, which was also raised by titanium (up to 0·06 per cent) and vanadium (up to 0·14 per cent) and lowered again by larger amounts of these elements. Boron showed a tendency to raise the transition temperature, but the amounts used had little effect. Sulphur had no effect on the transition temperature. Aluminium (0·5 lb

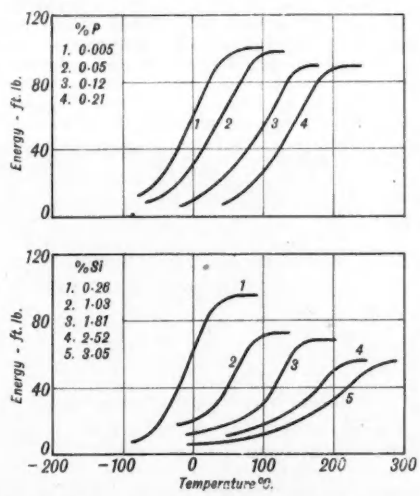


Fig. 3—*Effect of Phosphorus and of Silicon on the Shape of the Transition Curve (Rinebolt and Harris)*

per ton) reduced the transition temperature by about 35 deg. Cent., but larger amounts had no further effect. The only elements which lowered the transition temperature were manganese and to a lesser extent nickel (Fig. 1).

Carbon content has a marked influence on the shape of the impact value/temperature curve (Fig. 2). Addition of carbon raises the transition temperature, lowers the maximum energy and widens the temperature range. In steels with carbon 0·3 per cent, manganese 1·0 per cent and silicon 0·3 per cent, chromium had little effect until it reached 0·9 per cent, which is sufficient to modify the character of the pearlite; then it caused a considerable rise in transition temperature with no change in either maximum or minimum energy. Copper raised the transition temperature slightly and diminished the maximum energy. Molybdenum increased the transition temperature almost as rapidly as carbon and decreased the maximum energy.

The transition temperature was raised by phosphorus at the rate of about 7 deg. Cent. per

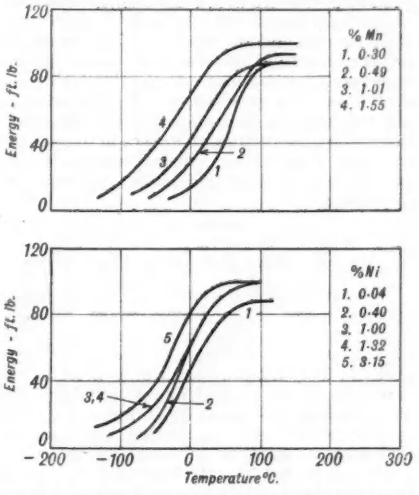


Fig. 4—*Effect of Manganese and of Nickel on the Shape of the Transition Curve (Rinebolt and Harris)*

0·01 per cent with slight decrease in the maximum energy, and by silicon at the rate of about 7 deg. Cent. per 0·1 per cent with considerable decrease in maximum energy. Both phosphorus and silicon widen the transition zone by changing the shape of the curves gradually as carbon does (Fig. 3).

The addition of manganese has a very different effect. It shifts the entire curve to a lower temperature without changing its shape. The maximum energy is not reduced, the values at the lower end of the curve remain the same and the width of the transition zone is unchanged (Fig. 4). Up to 1·5 per cent manganese, the transition temperature is decreased by about 6 deg. Cent. per 0·1 per cent (Fig. 1). Higher manganese contents, which produced a different type of microstructure, were excluded; and steels with less than 0·3 per cent were not studied. In steels with increasing nickel content the upper parts of the curves were all very similar, but in the lower portions (below 40 ft-lb) the impact value of the 3 per cent nickel steels fell less slowly at low temperatures than that of the corresponding carbon steels

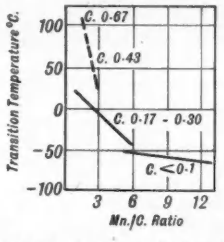


Fig. 5—*Effect of the Manganese/Carbon Ratio on the Transition Temperature (Rinebolt and Harris)*

and steels of lower nickel content (Fig. 4). The effect of carbon, manganese and nickel on the transition temperature is additive, i.e., manganese and (to a lesser extent) nickel tend to neutralise the effect of carbon in raising the transition temperature.

Importance of the Mn/C Ratio

The most effective practical means of lowering the transition temperature is by the addition of manganese. The paper gives information about the effect of the Mn/C ratio on steels

[1] American Society for Metals, Annual Convention, October, 1950, Preprint No. 33.

of different carbon content. Fig. 5 shows the transition temperature in relation to Mn/C ratio for steels of different carbon content. The authors state: "High manganese-carbon ratios have frequently been mentioned as being beneficial in ferritic steels," but they do not refer to the work of Barr and Honeyman,[2] carried out over five years ago and published in 1947. In normalised steels containing 0·1 per cent to 0·25 per cent of carbon they found a regular fall in transition temperature from +20 deg. to −50 deg. Cent. as the Mn/C ratio increased from 1·5 to 11·9. Those temperatures compare well with those for steels of similar carbon content in Fig. 5. The work of Barr and Honeyman definitely established the lowering of the transition range by increase of the Mn/C ratio; and their conclusions are supported by the results of Rinebolt and Harris, who have shown, moreover, that (apart from nickel, which has a similar but less pronounced effect) there is no other commonly used alloy element which will lower the temperature of transition from tough to brittle fracture in pearlitic steels, and at the same time give increased impact values at all temperatures.

An Earth Boring Machine

THE photograph reproduced below shows in operation one of a useful range of earth boring machines, which has been developed by the Magnetic Equipment Company, Ltd., of Cosham, Portsmouth, for drilling holes in the earth for telephone and power line poles, &c. The machines are made in different forms, as self-propelled units, as towing units, or for fitting on to tractors, or mounting on lorries. They can be used for drilling holes up to 24in diameter and down to depths of 8ft to 10ft.

Each machine consists essentially of link mechanism operated through a hydraulic ram

TRACTOR MOUNTED EARTH BORING MACHINE

and carrying an auger driven through a gearbox at the top of its shaft. The link mechanism is of very heavy construction and is so designed that it imparts a truly vertical movement to the auger throughout its range of movement.

In the case of the lighter types of boring units mounted on tractors, such as that illustrated, drive is transmitted to the auger gearbox through a telescopic transmission shaft fitted with duplex couplings, from the power take-off of the tractor. Duplex rubber couplings are fitted to the transmission shaft to reduce the effects of shock loading which may be encountered during the drilling operation. Machines of this type are suitable for drilling holes up to 24in diameter, 4ft or 6ft deep.

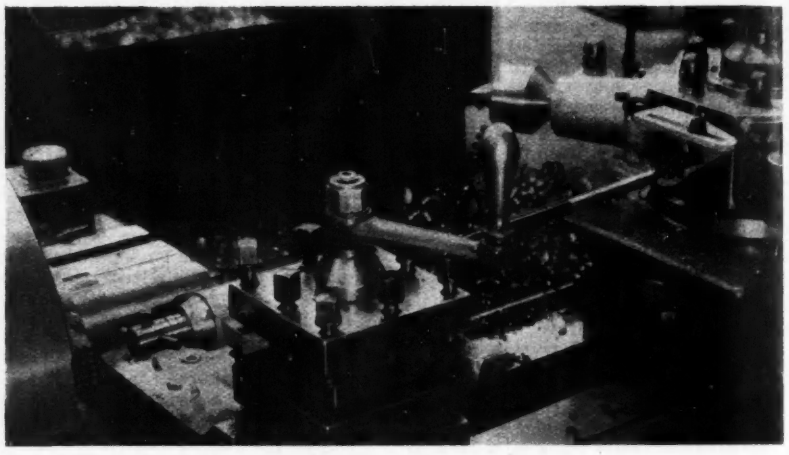
Larger machines for drilling holes 6ft or more are preferably mounted on a lorry and driven by their own 40 h.p. to 50 h.p. oil or petrol engines. In these units a much heavier linkage is employed and it is carried on a short mast. They are designed for drilling holes up to 6ft deep in one operation or 10ft when using a retractable auger.

The makers state that 21in diameter holes can be dug below the water line in heavy clay at a rate of 2½ft per minute and the augers can be easily withdrawn despite the heavy suction of a water-filled hole.

[2] *Journal* of the Iron and Steel Institute, October, 1947, pages 239 and 243.

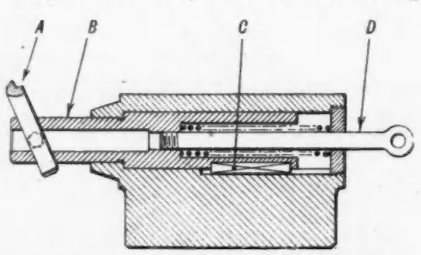
A Chasing Attachment for Lathes

WE have received particulars of a rapid thread chasing attachment suitable for most types of capstans and centre lathes, which is now being distributed in this country by Alfred Herbert, Ltd., of Coventry. The attachment, which is shown fitted on a capstan in the photograph reproduced below, has been specially designed to permit internal or external threading up to a shoulder at a high rate of production. When cutting threads up to a shoulder by chasing from the cross slide very accurate timing is necessary to slip the chasing mechanism when the tool is just clear of the shoulder, even with the spindle revolving at low speeds. The new attachment, which is simple to operate and easy to set, can be adjusted to cut any desired length of thread in a few minutes, and it stops positively at the same point after each cut.



CHASING ATTACHMENT ON A CAPSTAN

The mechanism of the "Barson" attachment, as it is known, is shown in the drawing



CHASING ATTACHMENT MECHANISM

reproduced here. The tool bit *A* is held by a set screw in the outer end of a sliding piston *B*, which is retained by the pressure of a strong spring at the extreme left-hand end of the travel in the barrel formed in the body of the attachment. A key *C* prevents rotation of the piston in the barrel. A draw rod *D*, passing through the centre of the spring and screwed into the piston, is attached by means of a telescopic connection to a bracket bolted to a face on the turret of the machine or on the tailstock.

When setting the attachment the position of the saddle is adjusted until the leading edge of the cutting tool is just clear of the shoulder. The turret slide is then moved back until the telescopic connection is fully extended and begins to pull against the spring pressure that retains the piston. The turret slide is then locked in position and the machine is set for the chasing operation.

When the spindle has been started and the tool has been brought to the beginning of its cutting stroke chasing commences and proceeds normally until the tool reaches the shoulder. At this point the telescopic connection is fully extended and arrests the movement of the tool. The saddle is, however, still being fed along the bed by the action of the lead screw and the tool holder barrel overrides the piston, thus compressing the spring. The total piston movement in the barrel is approximately ⅛in and graduations on the piston provide an indication of the speed of override, thus allowing the operator ample time in which to stop the chasing mechanism. It will be appreciated that with this attachment chasing can be stopped after the tool has reached the shoulder and much higher spindle speeds than are usually possible for this class of work can be used without involving the risk of scrap or expensive tool breakages. Subsequent recessing to clear the last thread is also unnecessary, as the tool begins to cut an annular groove immediately after its longitudinal travel is arrested by the turret slide.

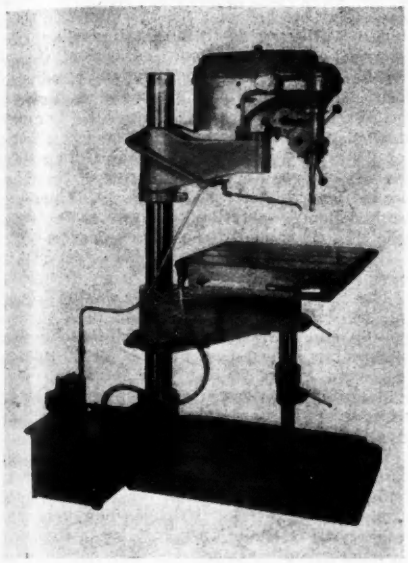
A Radial Drilling Machine

THE radial drilling machine illustrated on page 139 is a recent addition to the "Pacera" range of machines made by W. J. Meddings, Ltd., of Ipswich Road, Slough.

The heavy cast iron base of the machine has a ground and slotted face and rigidly supports a ground solid steel column, 4½in diameter. A swivelling arm, moved through a rack and pinion up or down the column, carries a 24in square work table, which is supported at its centre by a telescopic jack. A second swivelling arm, which is also slidably mounted on the column, supports the drilling head unit. This head is pivotally mounted on its arm and the combined swivelling movements of the head and the arm make it easy to position the spindle over any point of the work table. At the maximum setting the distance from the spindle to the column, or the throat depth of the machine, is 24in. The maximum spindle to table setting is 24in, but by swinging the work table round to the rear of the column large work can be mounted directly on the base casting, the surface of which is 46in below the spindle. The head, arms and work table are all carried on ball thrust races and can be locked rigidly in position by means of lever-operated clamps.

Self-contained drilling heads with either eight or ten spindle speeds can be supplied with the machines. Each type of head has a drilling capacity of ⅝in in mild steel and a spindle travel of 5in. The heads have totally enclosed oil-immersed gearboxes with a gear changing lever,

which gives high and low-speed ranges on four- or five-step cone pulleys. On the eight-speed head the spindle range is from 80 r.p.m. to



RADIAL DRILLING MACHINE

1500 r.p.m. and on the ten-speed head from 80 r.p.m. to 4000 r.p.m.

Extra equipment which can be supplied with a machine includes a coolant pump, a reversing switch, tapping attachments, &c.

American Engineering News

(From our American Correspondent)

A New Uranium-235 Production Plant

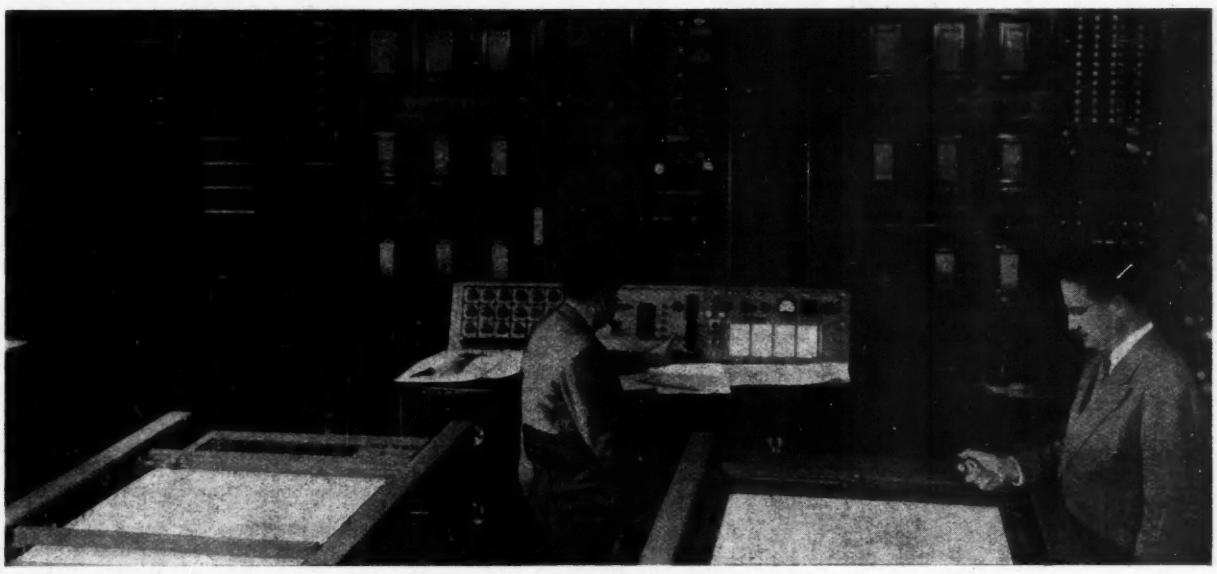
The U.S. Atomic Energy Commission has decided to construct a new production plant for Uranium-235 at a site near Paducah, Kentucky. The site covers about 5000 acres, and it is anticipated that a peak construction force of 10,000 workers will be required. When completed, the new facilities will be operated for the Commission by the Carbide and Carbon Chemicals Division of the Union Carbide and Carbon Corporation, which already operates the Commission's major production plant at Oak Ridge. The principal component of the works to be constructed will be a large gaseous diffusion plant for the separation of fissionable uranium-235 from non-fissionable uranium-238. This plant will supplement the extensive U-235 separation facilities now in operation or under construction at Oak Ridge. The gaseous diffusion process is one in which uranium-hexafluoride, in gaseous form, is pumped through thousands of extremely fine barriers which have millions of extremely small holes per square inch. Since the U-235 atoms are slightly lighter and, therefore, travel slightly faster, they strike the screens and pass through the holes with greater frequency than do U-238 atoms. Thus, the fissionable U-235 atoms, which make up only one part in 140 of natural uranium, are gradually separated and concentrated. It is believed that the operation of the plant will entail no appreciable radiation problems. During the five years which the similar Oak Ridge gaseous diffusion plant has been in operation there has not been a single case of an employee suffering a radiation injury.

The "Project Typhoon" Electronic Computer

The first public demonstration took place recently of "Project Typhoon," an electronic analogue computer designed and built by the Radio Corporation of America for the U.S. Navy Bureau of Aeronautics. Three years of development work preceded the construction of the computer, and the apparatus has been described as the largest and most accurate electronic analogue computer ever built to evaluate the performance of guided missiles and other objects which move through air or water, as well as to assist in the protection of cities against aerial attack. The machine, which is illustrated herewith, is designed to determine the performance of guided missiles by testing small-scale models, thus obviating the need of building the costly full-scale models and testing them in flight. It can perform the same services for ships, submarines, aircraft, and rocket-borne atomic bombs. A total of approximately 4000 electronic valves is employed in the computer. At its initial public demonstration the computer was made to solve a simulated air defence problem in which a high-speed bomber was successfully attacked by a radar-controlled, supersonic rocket-propelled guided missile. It was shown that no matter how violently the simulated bomber dodged, the simulated missile was guided to the target unerringly. All information necessary to solve the problem was introduced to the machine by means of more than 100 dials and a portion of the 6000 switchboard plug connections, which are mounted on the tall panel sections of the machine. Different dial positions and plug connections represented such characteristics as the aerodynamics of the missile, loss of weight due to fuel consumption and radar signals following both the missile and the target. Other adjustments accounted for the automatic pilot unit or the gyroscopic stabilisers of the missile, the path and velocity of the target and the main guidance system to be employed for directing the missile toward the target in the most effective manner. While the instrument was in operation the paths of both the high-speed bomber and the rocket-propelled guided missile were traced respectively by red and green pens on the two large plotting boards shown in the foreground of the illustration. The charts thus produced provide a permanent record of any test flight and enable the exact position of the missile to be determined at any given time. The basic mechanism of the new computer consists of a hybrid between an analogue and a digital computing unit. By making use of a combination of these two fundamental computing techniques, "Project Typhoon" is said to achieve a combination of flexibility and accuracy unobtainable by either of the systems alone. A staff of nine engineers and mathematicians as well as six technical assistants are required to operate the computer when it is solving guided missile problems of a complex nature. The machine contains approximately 600 relays for multiplication purposes, which operate in 1/10,000 second. To keep the sensitive instrument free of climatic influences it is situated in a special air-conditioned room, which has a constant temperature of 75 deg. Fah. and a relative humidity of not more than 50 per cent.

Progress of T.V.A.

A considerable increase in capacity has been announced in the latest annual report of the Tennessee Valley Authority. The generating capacity of the T.V.A. power system has been multiplied nearly four times since 1940. The current construction schedule is designed to increase the installed capacity of the system from 3000MW at the present time to 4900MW by 1953. During the last year, the T.V.A. power system produced 17½ billion kWh—twelve times the energy which was generated in the region in 1933. In the field of flood control, the system, which now provides 11,000,000 acre-feet of storage for the regulation of flood waters, lowered two crests of a flood of long duration on the lower Ohio and Mississippi rivers, the first by about 2ft and the second by over 1ft. No major flood crests occurred on the Tennessee, but regulation averted damage to the extent of 800,000 dollars at Chattanooga, Tennessee, bringing the total since 1936 to 45,000,000 dollars. At this particular point alone, savings in damage have amounted to more than a quarter of the



R.C.A. ELECTRONIC COMPUTER

T.V.A. flood-control investment. The net operating revenues of the system were 27,000,000 dollars, equivalent to a return of 5¾ per cent on the average depreciated power investment. Over the entire period of T.V.A. operations, the return has averaged 4 per cent annually. During the past year the number of consumers was increased by 110,000, of which 63,000 were farms. Farm electrification has advanced to 82 per cent of the total, compared with about 3 per cent in 1933. In the T.V.A. region, the average domestic consumer used 3079kWh during the year at a total cost of 46 dollars; in the whole of the U.S. average consumption was 1765kWh at a cost of 51 dollars.

Major construction activity during the past year was concentrated on two large steam-electric generating stations—Johnsonville, on the Kentucky reservoir, and Widow's Creek, on the Guntersville reservoir. These two stations will add more than 1100MW to the installed capacity of the T.V.A. system. The major hydro-electric installation, which was brought close to completion in 1950, is South Holston dam, a 285ft high earth and rock-fill structure. The project is to have an eventual installed capacity of 35MW and initial power production is scheduled for February, 1951. As a result of the malaria control measures being employed by T.V.A., the Authority feels that reservoirs can now be built in any part of the U.S. without danger of increasing the malaria hazard in any particular area. In 1949, 4300 human blood samples taken in "problem" areas along the T.V.A. lakes showed no evidence of malarial infection. In the first survey, conducted in 1934, 28 per cent of the samples taken contained malaria parasites. In the field of fertiliser production, extensive research and manufacturing facilities are being maintained at Muscle Shoals, and during the past year T.V.A. produced 113,000 tons of concentrated superphosphate and 123,000 tons of ammonium nitrate fertiliser, together with lesser quantities of calcium metaphosphate and fused tricalcium phosphate.

Steel Mill for Japan

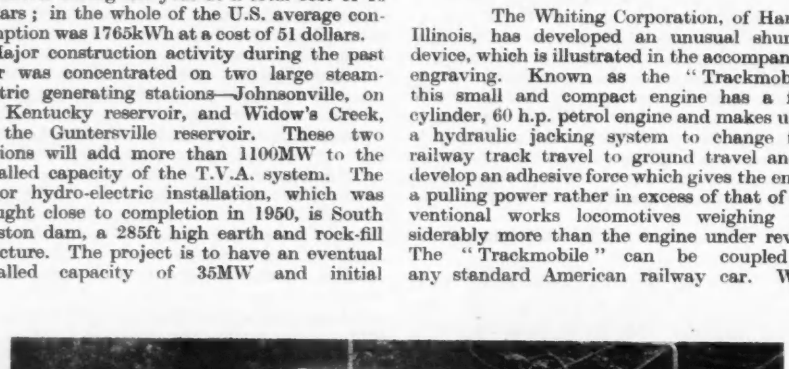
Rolling mill machinery forming the nucleus of a modern continuous steel strip mill is being manufactured by the Lewis Foundry and Machine Division of the Blaw-Knox Company, of Pittsburgh, for the Nichia Steel Works, Ltd., of Kobe, Japan. The order for the equipment and design services involved is said to amount to 1 000,000 dollars.

Gas Turbine-Electric Locomotives for Union Pacific Railroad

The Union Pacific Railroad has placed an order for ten gas turbine-electric locomotives with the General Electric Company, of Schenectady. The locomotives will be similar to the 4500 h.p. unit which has been under test by the Union Pacific on regular freight runs during the last year and a half. The new units will be built at the General Electric works at Erie, Pennsylvania, and deliveries are to begin in the autumn of this year. The locomotives will have a weight of 225 tons, will be 83ft 7½in long, and will have a maximum speed of 65 m.p.h. They will burn low-grade fuel oil. The locomotives will be employed in regular freight service, to facilitate a full evaluation, under a variety of operating conditions, of the potentialities of the gas turbine-electric form of motive power.

A Combination Road-and-Rail Shunting Engine

The Whiting Corporation, of Harvey, Illinois, has developed an unusual shunting device, which is illustrated in the accompanying engraving. Known as the "Trackmobile," this small and compact engine has a four-cylinder, 60 h.p. petrol engine and makes use of a hydraulic jacking system to change from railway track travel to ground travel and to develop an adhesive force which gives the engine a pulling power rather in excess of that of conventional works locomotives weighing considerably more than the engine under review. The "Trackmobile" can be coupled to any standard American railway car. When coupled, a hydraulic jack raises the coupler, thus forcing the shunting engine down on the track and transferring a portion of the weight of the car to the engine. This considerable increase in vertical force enables the shunting engine to develop a draw-bar pull of 7350 lb at 1·5 m.p.h. Its own weight is only 6000 lb. The four rubber-tyred wheels for ground travel are retracted hydraulically when the engine is positioned for track operation. The manufacturer claims that the change-over from ground to railway track operation takes only thirty seconds. The maximum ground speed of the unit is 25 m.p.h., and the track speed varies with the load being pulled. It is said that on account of its flexibility the "Trackmobile" has an important advantage over conventional works locomotives, in that it can be moved quickly from one shunting operation to the next, travelling across the yard on its rubber-tyred wheels.



"TRACKMOBILE" SHUNTING ENGINE

Extrusion of Steel Tubes

The National Tube Company, a subsidiary of the United States Steel Corporation, has decided to build a large extrusion plant for the manufacture of high-alloy seamless steel tubes at its Gary Works in Gary, Indiana. The installation of these facilities will bring about the first application in the U.S. of the extrusion process on a commercial basis to the manufacture of seamless steel tubes. The process to be employed in the operation is the French Ugine-Sejournet process for the hot extrusion of metals, using glass as a lubricant. The installation will consist of a 2500-ton hydraulic extrusion press and related facilities for the production of tubes ranging from 1½in to 6½in diameter, having wall thickness up to ½in and lengths up to 60ft. The plant will have a capacity of approximately 3000 tons per month.

French Engineering News

(From our French Correspondent)

Marshall Aid credits amounting to 4,560,000 dollars have been granted for the modernisation of two steel plants. Of this sum 2,500,000 dollars will be spent on purchasing rollers and electrical equipment from the United States for the Longwy steel plant, and the remainder for the purchase of equipment for the Société des Forges et Aciéries de Dilling. The Longwy steel plant produces about 10 per cent of the total French steel output, and the Dilling steel works produces about one-quarter of the Saar production. The new rolling mills will increase Franco-Saar production of sheet metal from 800,000 tons annually to a million or more tons.

* * *

The Paris Transport Office is asking for 80 million francs for the extension of a metropolitan underground line and the introduction of new bus services, an advance of 50 million francs to cover the costs of reopening four underground stations and 18 milliard francs to cover an extensive plan for the renewal of rolling stock within ten years.

In his report, Monsieur Ruais, the President of the office, stated that the Paris Transport budget had been balanced for the first time since the war. This balance, however, was unlikely to be maintained in view of increases in salaries and personnel unless tariffs were raised.

Monsieur Ruais explained that the plan for renewal of rolling stock covered 100 complete trains and 2000 buses, which would gradually replace those in service. State aid would not be asked, the expenditure being covered by medium-term loans from banks.

* * *

Despite efforts to increase rolling mill production, deliveries are still difficult due to shortage of fuel, scrap, ferro-manganese and personnel. Orders are still numerous and important, and it is feared that some form of rationing may have to be introduced. An increase in prices is also feared. November production of steel amounted to 998,000 tons, against 1,044,000 tons in October, due to fewer working days, although daily production was 41,500 tons in November against 40,100 tons in October. Finished rolled products amounted to 730,000 tons in November against 709,000 tons in October, which is higher than the best results so far reached since the liberation, despite difficulty in obtaining fuel and scrap.

* * *

The plan to modernise the French coalfields was intended to extend over ten years. By 1952 production was to reach 69 million tons, to increase to 74 million tons in 1955. The nationalised mines were to supply 66 million tons and 71 million tons respectively of these totals. Revision of the plan in 1947–8 reduced the 1952 target to 58 million tons and the 1955 target to 63 million tons, while in 1949 the final term was fixed at 1953 instead of 1955, and the target to 60 million tons. In 1950, owing to restriction of credits, work was slowed down and the 1952 target dropped to 54 to 55 million tons.

According to results for the first eleven months of 1950, French production for the year has been estimated at 52,500,000 tons, against 53 million tons in 1949. Personnel dropped from 280,364 in January, 1950, to 263,683 on November 25th. Productivity improved, daily output per miner at the coal face being 1230kg, equal to the 1938 level. For the last week in November it rose to 1274kg. Total imports dropped from 1,038,515 tons in January, 1950, to 611,315 tons in September.

While paying a tribute to the rise in productivity, Monsieur Delfortrie, a senator of the Nord Department, reporting to the Conseil de la Republique, stated that the rising cost of living in France was bound to bring renewed demands for increased wages from the miners. Miners had been given an increase of 8·5 per cent, which meant 8·5 milliard francs supplementary expenses for the mines.

Industrial and Labour Notes

Material Shortages

As a result of conferences between representatives of the Governments of this country, the United States and France, proposals have been made for the introduction of new international machinery to deal with material shortages. In these conferences consideration was given to ways and means of bringing about co-operation amongst countries to increase the production and availability of materials in short supply and to ensure their most effective use. Events of the last few weeks have made it clear that commodity problems cannot be dealt with on a regional basis but must take account of the needs and interests of the whole of the free world. It has therefore been decided that continuing international machinery is needed, through which all interested governments of the free world, whether or not members of the Organisation for European Economic Co-operation, the North Atlantic Treaty Organisation or the Organisation of American States, can co-operate in the solution of commodity shortages, which are world-wide in scope and effect.

The Governments of the United Kingdom, France and the United States have now agreed that proposals should be made to other interested governments for the creation of a number of standing international "commodity groups," representing producing and consuming countries, which have a substantial interest in the commodities concerned. These groups, it is suggested, should consider and recommend to governments the specified action which could be taken in the case of each commodity in order to expand production, increase availability, conserve supplies and ensure the most effective distribution and utilisation of supplies amongst the consuming countries. As early action is called for in respect of certain commodities, the Government of the U.S.A. has agreed to send invitations immediately to other interested friendly governments for the establishment of certain standing commodity groups. A temporary central group is to be set up immediately in Washington to provide a servicing means for these standing commodity groups. Interested governments and appropriate international organisations are to be consulted at an early date about the continuing functions and membership of the central group.

It was announced in London at the end of last week that Lord Knollys had been appointed to represent the United Kingdom on the temporary central group which is being established. The Federation of British Industries stated that Lord Knollys would have the full support and confidence of British industry in carrying out his important task.

Prohibited Uses of Copper and Zinc

Since making the announcement on December 28th about the proposed prohibition of the use of copper and zinc in manufacturing specified articles, the Ministry of Supply has received representations from several industries affected. In order to minimise, as much as possible, the difficulties likely to be met by those industries, the Ministry of Supply and the Board of Trade have decided that the prohibition order shall date from March 1st, and not February 1st, as originally intended; and that the Order shall include permission to firms to use, between March 1st and June 30th, any stocks of semi-fabricated metal and partly processed articles in their possession on March 1st.

In announcing this postponement, the Ministry of Supply has reiterated that the prohibitions are unavoidable in view of the world shortage of copper and zinc and in view of the urgent need to ensure that available supplies are used for essential purposes.

The Industrial Situation

Among the annual reports published at this time of the year are those of the British banks. They are always accompanied by chairmen's statements which make useful comment on many aspects of the prevailing industrial and economic situation.

The statement by Lord Aldenham, chairman of the Westminster Bank, Ltd., issued this week, remarks on the notable increase in industrial production, but says that much more still can be achieved in that direction. Lord Aldenham thinks that a clear lead from the Government on the need for increased production, to give the armed strength necessary to avoid war, will help; but, he asserts, for the real driving power, the country must look to individual directors, individual managers and individual men. Many large companies, his statement continues, have shown how much they have been able to increase their own production by improvements in their already good management without additional strain on their workpeople, but much progress on both sides of industry remains to be achieved. The statement points out that shortages of raw materials will check production in some industries in 1951; but, Lord Aldenham says, reports from the bank's branches all over the country refer to the undermanning of many industries. That undermanning and the needs of the Services, he claims, should absorb any labour displaced by the lack of raw materials. But the difficulty of persuading men displaced from one industry to take up work in another is formidable, as is exemplified by the grave lack of manpower in the coal-mining industry.

In the statement by Sir William Goodenough, which accompanies the report of Barclays Bank, Ltd., the recommendation is made that this country ought now to keep its thoughts and actions bent more than ever upon competitive efficiency. It would serve a double purpose, Sir William says, as it would give us strength and resilience to meet a situation such as it was feared might be developing a year ago, and it would help us to deal with the new and quite different problems which have since arisen. There is a great deal to the credit of all who are engaged in British industry, the statement continues, and it is most heartening to see what has been achieved. The improvement in industrial production has been at a much faster rate than was thought likely, and, as post-war investment has begun to show results on an increasing scale, standards of efficiency have risen. But Sir William considers that we have not encountered the full force of competition, and maybe shall not do so for some time.

Manufacturers and Taxation

With the forthcoming Budget in mind, the National Union of Manufacturers has submitted to the Chancellor of the Exchequer a memorandum setting out its views on the effect upon industry of the present high rate of taxation. In spite of past warnings, the memorandum says, nothing has been done to reduce Government expenditure within manageable limits, and the already overstrained economy now has to meet, on top of all other commitments, £300,000,000 or more a year for the rearmament programme. The National Union fully realises the vital importance of everything possible being done to put the nation in a position of defence against all possible aggressors, but nothing, it feels, is more certain than that industry cannot possibly stand any additional taxation burden and remain prosperous and competitive in overseas markets.

The memorandum therefore points out, once more, that the unprecedented level of State expenditure—more than 40 per cent of the national income—is so serious in its results that drastic measures are required to correct it. It is not a question whether any given expenditure is desirable or meritorious, but whether at the present time, particularly with the added burden of rearmament, the country can afford it. The National Union of Manufacturers therefore urges that a complete overhaul of Government expenditure should take place forthwith, and that, to perform the task, an independent body should be appointed for the express purpose of stopping or curtailing every item of expenditure which is not absolutely vital to the nation's defence and economic health.

Some detailed recommendations on profits tax, purchase tax, income tax and death duties are then put forward in the memorandum. The National Union's view is that purchase tax as a fiscal measure has nothing to recommend it, and thinks that the need for a purchase tax should gradually be removed by economies in public expenditure, apart from defence. The union also repeats a recommendation made last year that the profits tax on undistributed profits should be repealed, and recommends that the existing maximum allowance of £2500 as the chargeable remuneration of working directors—in cases where directors have a controlling interest—should be increased to a figure commensurate with an adequate salary for each working director actively engaged in the business.

Wages in the Electricity Supply Industry

The National Joint Industrial Council for the electricity supply industry held a meeting on Friday of last week, at which a decision was reached about alterations to the existing wages agreement. The wages of trades set out in Schedule (a) of the national agreement of July 20, 1949, are now to be increased by 1½d. an hour from the pay day in the week beginning January 29, 1951, for the period covered by that pay day.

Employment in the Steel Industry

In the latest issue of its *Monthly Statistical Bulletin*, the British Iron and Steel Federation shows that, on November 4, 1950, the total number of people employed in the iron and steel industry was 455,103 and that the average weekly earnings of the process, maintenance and clerical workers were £8·03. On the comparable date in 1949 the total number of workers was 447,166. The Federation comments, in the *Bulletin*, on the progressive attitude of the iron and steel trade unions, saying that in the post-war period the unions have given the clearest evidence of their support in aiming at greater production and efficiency. An outstanding example, it is added, was the negotiation of the continuous working week in 1947. Under that arrangement it was decided that, in all cases where it was technically advantageous, steel furnaces would operate continuously, the workers taking it in turns on a shift basis to work during the week-ends. The arrangement was combined with the forty-eight-hour week and with the claim by the workers that a forty-two-hour week should be introduced as soon as conditions made it possible.

In the January number of *Man and Metal*, which is the journal of the Iron and Steel Trades Confederation, Mr. Lincoln Evans, the general secretary, has referred to the great changes in the pattern of industrial relations since the beginning of the century. Not the least, he says, is that there is a new generation of managers in industry, whose minds are not coloured by the old hostilities which grew up in the period when the trade union movement was trying to establish itself. On the trade union side, Mr. Evans claims, there has been some change, and gradually the fundamental economic fact is being realised that the only real road to an increased standard of life for all is that of increased productivity. Referring to the substantial increase achieved in industrial production last year, Mr. Evans mentions his Confederation's decision to ask for a resumption of negotiations on the forty-two-hour week claim for those members who agreed in 1947 to operate the continuous working week. Despite the fact, he says, that the international situation has worsened since that decision was made, "the claim cannot be deferred any longer, because if we are to wait until there is no economic, social or international crisis in these uncertain times, this would mean deferring it indefinitely."

Notes and Memoranda

Rail and Road

BRITISH TRANSPORT TRAFFIC RECEIPTS.—The British Transport Commission has reported that in the fifty-two weeks of 1950, traffic receipts on British Railways amounted to £335,555,000, compared with £321,176,000 in 1949. Provincial and Scottish road passenger transport traffic receipts were £37,971,000, compared with £35,101,000; London Transport traffic receipts were £55,893,000, compared with £56,536,000, and tolls and freight charges on inland waterways totalled £1,622,000, compared with £1,520,000. The 1950 figures are, of course, affected by the increased freight traffic charges which were introduced by British Railways and the Inland Waterways Executive during the year, and by the London area passenger charges scheme which came into operation last October.

Air and Water

NEW YORK CUSTOMS SERVICE.—More than 775,000 passengers, 450,000 by sea and 325,000 by air, entered New York in 1950, a figure 55,000 in excess of 1949. The Customs service examined 2,480,000 pieces of luggage, made 4200 seizures of illegal goods, searched 2263 ships and 133 aircraft, besides guarding 771 miles of waterfront.

THE KHAKARKHEDA HYDRO-ELECTRIC STATION.—A report by *Indian Trade and Industry* records the opening, recently, of a 20MW hydro-electric power plant at Khakarkheda, 12 miles from Nagpur. It is the first station to be constructed under a development programme initiated by the Government of Madhya Pradesh, and before the end of this year its capacity will be increased to 30MW. The plant will feed twenty-one substations, covering the coalfields and manganese mining areas.

Miscellanea

THE LATE MR. W. E. GOUGH.—We have learned, with regret, of the death of Mr. William Eric Gough, A.M.I.E.E., which occurred at Coventry on January 10th. Mr. Gough, who was in his fifty-first year was on the aero-magneto engineering and design staff of the British Thomson-Houston Company, Ltd. He joined B.T.H. as a student apprentice in 1919.

EASTHAM OIL DOCK.—In the article "Harbours and Waterways in 1950," appearing in last week's issue, it was erroneously stated on page 84 that the contractor for the construction of Eastham oil dock was Sir Robert McAlpine and Son, Ltd. In fact the contractor for this work is Sir Alfred McAlpine and Son, Ltd., Hooton, Little Sutton, Wirral, Cheshire.

TELEVISION SERVICING CERTIFICATE.—The Radio Trades Examination Board announces that arrangements have been made for the examination of candidates who live outside the range of a B.B.C. television transmitter. These candidates will be accepted for the written papers only on the understanding that they will sit for the practical examination within twelve months of the opening of a television transmitter in their area. The certificate will not be issued until the completion of the examination. In view of this, arrangements are being made for candidates from Scotland to sit for the written papers of the May, 1951, examination.

COLD PRESSURE WELDING.—The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C.2, has just published the second edition of its booklet on cold pressure welding. This process, which is particularly applicable to aluminium and other common non-ferrous metals and alloys, consists of joining metals by means of homogeneous welds produced solely by pressure at room temperature. It was developed by the firm three or four years ago and was dealt with in THE ENGINEER of April 30 and June 4, 1948. Since that time a number of new developments have been made in the process. The new edition of the book, in addition to dealing in detail with the process, gives its limitations and an estimate of its uses in industry.

ACCIDENT PREVENTION COMPETITION.—A safety competition, open to all cement works in Great Britain and Northern Ireland, is being organised by the Cement Makers' Federation. It is a development of the scheme for the study of accident prevention throughout the cement industry. The scheme has the full support of all the companies and will be run concurrently with the safety activities operated separately by each organisation. The basis of the competition is the international frequency rate of accidents. Cement works are classified in divisions and the unit in each division with the lowest accident frequency rate of the year will be deemed the winner. Awards, which will take the form of a bronze plaque, will be made to the winners by the Cement Makers' Federation and, in addition, a perpetual challenge trophy will be held by the works having the lowest frequency rate of all competing units. The first awards will be made at the end of 1951, based on the returns for the year. Full particulars of the competition are available from the Cement Makers' Federation, Terminal House, 52, Grosvenor Gardens, London, S.W.1.

STOURPORT "B" POWER STATION.—In an article on page 24 of our issue of January 5th we stated, in a reference to Stourport "B" power station, "Steam for the first set is supplied by a 525,000 lb per hour Stirling boiler, with a slag tap furnace and a similar installation will serve the second set." In fact the second set will be supplied by an International Combustion radiant heat boiler of 525,000 lb per hour capacity, but having a dry ash hopper.

THE ROYAL SHOW AT CAMBRIDGE.—The Royal Agricultural Society reports good progress in the preparations for this year's Royal Show, which is to be held at Cambridge, from July 3rd to 6th. The showground, situated at Trumpington, has an area of 150 acres, running through which is Hobson's Brook. Nine bridges, in addition to an existing one, are to be erected across the brook, at intervals of about 100 yards, and five of them will accommodate vehicles as well as pedestrians. The machinery and other trade exhibits will occupy about 70 acres. A new feature of the "Royal" will be a 100ft-high mast, surmounted by a distinguishing sign, erected in the centre of the showground. It will help visitors in the task of "direction finding," and will probably be used also for television.

INSTITUTION OF MINING ENGINEERS.—At the annual luncheon of the Institution of Mining Engineers, which was held in London on Thursday, January 18th, the President, Sir Andrew Bryan, presented the Institution awards for 1950. The Institution Medal, the highest award of the Institution, was presented to Monsieur Etienne Audibert, President of the Charbonnages de France, in recognition of his services to mining engineering and his work in research into safety in coal mines. The first Douglas Hay Medal was awarded to Professor J. Ivon Graham in recognition of his outstanding contributions to the "Transactions" of the Institution and his work for the improvement of the health and welfare of miners. Mavor and Coulson Students' Prizes were awarded to Mr. K. Z. George, Mr. C. R. Lloyd Jones, and Mr. E. J. Polak; the Victor Students' Prize to Mr. H. S. Alpan, and the Laurence Holland Prize to Mr. N. E. Roberts.

MECHANICAL TESTS.—The Northern Aluminium Company, Ltd., has recently published a revised and enlarged edition of its booklet, entitled "Mechanical Tests and their Bearing on Working Properties," which is intended primarily for students. In the introduction the mechanical properties of the greatest significance are listed and it is stressed that the fabricating process and conditions of service to which the material will be subjected, should be considered in determining the properties. The values deriving from the tensile tests are defined, the machines and methods used are described and typical stress strain curves are given. Among the other tests the Brinell, Vickers Diamond Pyramid and Avery hardness testing machines are mentioned and the method of obtaining the hardness number described. The Erichsen cupping test machine, which indicates the quality of sheet material for deep drawing is illustrated and a graph is given showing curves of constant temper plotted against depth of draw and sheet thickness. Other tests mentioned are the bend test, which gives information regarding the forming properties, the shear test and the use of the Izod testing machine for obtaining notched bar impact strength values. Fatigue tests are discussed and a curve given for a particular aluminium alloy. The final chapter links the mechanical properties to the working characteristics of aluminium and its alloys with relation to the various operational processes.

Contracts

THE Weir Wood Water Board has accepted the tender of Foundation (Plant), Ltd., of Martins Bank Chambers, 179, High Street, Bromley, Kent, for the contract for the construction of Turners Hill service reservoir, at a cost of nearly £52,00. The work involved comprises the construction of a reinforced and mass concrete service reservoir of 4 million gallons capacity, together with other ancillary works. The consulting engineers for the contract are Herbert Lapworth Partners, of 25, Victoria Street, Westminster, London, S.W.1.

Personal and Business

A. C. WICKMAN, Ltd., Coventry, has assumed the sole agency in the United Kingdom for Usines Tornos, Switzerland.

PETER STUBS, Ltd., announces the appointment of Mr. W. Kelsey as general manager of its steel works at Rotherham.

THE SKINNINGROVE IRON COMPANY, Ltd., states that Mr. C. A. Reed, works manager since 1939, has been appointed a director.

DANKS OF NETHERTON, Ltd., Netherton, Dudley, states that Mr. H. Fletcher, director and general manager, has been elected chairman of the company.

MR. H. P. BARKER, managing director of Parkinson and Cowan, Ltd., has been appointed a part-time member of the British Transport Commission.

LAURENCE, SCOTT AND ELECTROMOTORS, Ltd., announces the appointment of Mr. D. G. Maynard as sales engineer attached to the Lancashire sales office.

A.C.V. SALES, Ltd., states that Mr. Stanley Hollands has been appointed an executive director and director-in-charge of the company's technical services.

TRIPLEX SAFETY GLASS COMPANY, Ltd., has acquired the engineering firms Stern and Bell, Ltd., Birmingham, and Weldall and Assembly, Ltd., Stourbridge.

MR. R. BUCKLEY has been appointed publicity manager for Brimar valves and the industrial supplies division of Standard Telephones and Cables, Ltd., Footscray, Kent.

MR. S. M. FINLAYSON has been elected president of the Canadian Marconi Company in succession to Mr. A. H. Giman, who has relinquished that office. Mr. Giman continues on the board of the company.

MR. C. A. CLENCH, M.I.Mech.E., has been appointed chief generation engineer (construction) of the London division, British Electricity Authority, in succession to Mr. A. Pollitt, M.I.Mech.E., who has become deputy divisional controller.

HADFIELDS, Ltd., Sheffield, announces the retirement at the end of this month of Mr. J. B. Thomas from the offices of deputy chairman and managing director. Mr. Harold Humphries, at present deputy managing director, is to succeed Mr. Thomas.

W. T. HENLEYS' TELEGRAPH WORKS COMPANY, Ltd., states that Mr. F. E. Saunders has been appointed assistant manager of the Glasgow branch. Mr. F. J. Thornton has been appointed the company's engineering representative for the whole of Scotland.

MR. R. F. OTTIGNON has relinquished the office of managing director of Metalclad, Ltd., owing to his new responsibilities with K. and L. Steelfounders and Engineers, Ltd. He will continue to serve on the board of Metalclad, Ltd., of which Mr. Philip B. Levy has been elected managing director.

THE CABLE MAKERS' ASSOCIATION announces that Mr. E. C. Holroyde, of Crompton Parkinson, Ltd., has been elected chairman. Appointments to affiliated associations have been made as follows:—Mr. H. B. Davies, Chairman of Mains Cable Manufacturers' Association; Mr. C. H. Broughton Pipkin, Chairman of Rubber and Thermoplastic Cable Manufacturers' Association; and Mr. F. W M. Lewis, Chairman of Overseas Rubber Cable Manufacturers' Association.

Launches and Trial Trips

SATURNUS, motor tanker; built by the Furness Shipbuilding Company, Ltd., for Rederiaktiebolaget Saturnus, Sweden; length between perpendiculars 496ft, breadth moulded 67ft 6in, depth moulded 36ft 5in, deadweight 16,445 tons on 29ft ¾in draught; twenty-one oil compartments; N.E.M.-Doxford single-acting, two-stroke, airless injection oil engine, five cylinders, 670mm diameter by 2320mm combined stroke, 5500 b.h.p. at 114 r.p.m., two Scotch boilers supply steam to cargo pumps and deck machinery. Trial, December 29th.

BRITISH VISCOUNT, motor tanker; built by Swan, Hunter and Wigham Richardson, Ltd., for the British Tanker Company, Ltd.; length between perpendiculars 463ft 5½in, breadth moulded 61ft 9in, depth moulded 34ft 1in, deadweight 12,150 tons; Swan, Hunter-Doxford oil engine, four cylinders. Launch, January 8th.

MANCHESTER MERCHANT, cargo liner; built by the Blythswood Shipbuilding Company, Ltd., for Manchester Liners, Ltd.; length 440ft, breadth 59ft, depth 38ft 4in, deadweight 9790 tons; one set of single-reduction geared turbines taking superheated steam from three cylindrical boilers, 16½ knots. Trial, January 18th.

British Patent Specifications

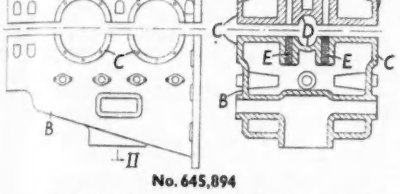
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

INTERNAL COMBUSTION ENGINES

645,894. August 12, 1948.—Improvements in or relating to the Crankcases of Internal Combustion Engines of the Type having Horizontally Opposed Cylinders, Harry Robert Mayes, of 77, Dordans Road, Leagrave, Luton, Bedfordshire.

The accompanying drawing shows an outside elevation of a crankcase and a sectional elevation on the line *II—II*. The crankcase is divided into upper and lower portions *A* and *B* and the plane of division is diametrically through and lies parallel with the bores of the cylinders on each side of the crankcase. The circular seatings on which the cylinders are mounted are shown at *C*. The plane of division also contains the centre lines of the main crankshaft bearings, the housings of which are shown at *D*. If desired, the bottom portion of the crankcase may be subdivided into two or more

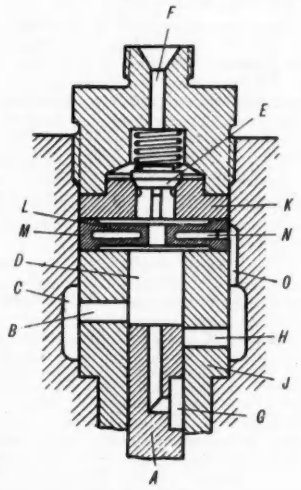


No. 645,894

parts to facilitate casting, internal inspection, cleaning and/or to provide a readily detachable oil sump independent of the main lower half of the crankcase to which the cylinders are attached. The invention permits the use of very short studs to secure together the two parts of the crankcase, such studs being screwed into tapped holes *E* in the lower part of the crankcase, and the nuts for the studs engaging seatings *F* located within pockets *G*. Owing to the manner in which the crankcase is split, separate main bearing studs are not required. It is claimed that crankcases constructed in accordance with this design combine lightness, strength, rigidity, and homogeneity, and the construction lends itself to greater simplicity and fewer machining operations, with consequent saving of time and handling.—*November* 8, 1950.

648,297. January 1, 1948.—Improvements in and relating to Fuel Injection Pumps for Internal Combustion Engines, Anton Pischinger, of 9, Felix-Dahnplatz, Graz, Austria.

By this invention the elastic limitation of the working space of a pump is obtained by means of a resilient cell or capsule, which is inserted as



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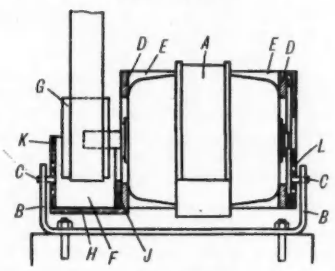
an intermediate member between the pump barrel and the delivery-valve casing. The pump piston or plunger *A*, which is driven in the usual way by a cam, displaces during its upward motion at first a portion of the sucked-in fuel through the suction passage *B* back into the suction chamber *C*, until its upper edge has moved beyond the suction port *B*. From this moment onwards the piston displaces the fuel out of the working space *D* by way of the delivery valve *E* to the injection passage *F*. This fuel delivery continues until a control groove *G* uncovers the spill port *H*, whereupon the fuel flows back into the suction chamber *C*, at the same time relieving the pressure in the working space *D*. The control groove *G* extends helically round the periphery of the plunger *A*, the end of the injection period being regulated in the usual manner by rotating the plunger about its axis. Between the plunger guiding means, in the form of a separate pump barrel *J*, and the inserted delivery-valve casing *K*, is set an elastic annular cell or capsule *L* in the form of a double diaphragm. The outer annular portion *M* of the cell is thickened so that the cell is firmly held to form a tight joint between the pump barrel and the delivery-valve casing *K*. The remainder of the superficial area of the cell is acted upon by the pressure prevailing in the working space of the pump. The hollow space *N* of the cell is in communication through a passage *O* with the suction chamber *C* so that when the cell is compressed, a rise in pressure in the space *N* is avoided and any oil which may leak out is caught. In this way existing pumps can be adapted and provided with an elastic member. In operation, under the action of the pump pressure, the elastic member is compressed until it balances the pump pressure.—*January* 3, 1951.

ELECTRICAL ENGINEERING

647,838. December 31, 1947.—Support for Dynamo-Electric Machines, Rudolph Poeschl, 14, Grosse Mohrengasse, Vienna, Austria; and Wilhelm Poeschl, 41, Rohrbach, Austria.

Although the invention is primarily applicable for electric motors with belt pulley drive, a generator may be constructed in the same manner. As shown in the accompanying drawings, the motor *A* is pivotally supported by a rocking support *B* by means of bolts *C*. The motor casing is provided at both ends with flange rings *D*, connected to the motor casing by means of the bars *E*. To these flange rings there are fastened at both ends the elements for supporting the motor on the rocking support. At the end opposite the driving end this element is formed by an annular disc, which has apertures for carrying the pivot bolt *C*. At the

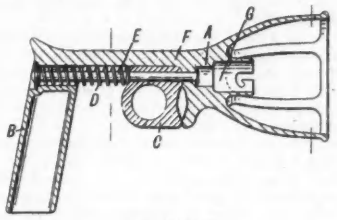


No. 647,838

driving end, however, the bearing element consists of a part *F* enclosing the belt pulley *G* and which partially surrounds the pulley to form a protective cap. This cap may comprise a tubular part *H*, to which is welded on one side an annular segment *J* and on the other side a semi-circular disc *K*. The annular segment *J* has screw holes for fastening the protective cap on the flange ring *D*, while the disc *K* is provided with apertures *L* for the pivot pins *C*. To provide means of adjustment of the radial distance of the pivot axis from the motor axis several apertures are provided so that the pivot bolt can be fitted to an appropriate aperture. This construction of the cap and of the disc permits the same arrangement to be applied for different types of drives, and over-drives and mid-drives are also shown.—*December* 20, 1950.

648,227. December 23, 1948.—Improvements in Electric Inspection Lamps, James Neale and Sons, Ltd., of 68, Graham Street, Birmingham, 1, and Michael Rowland Neale, of the company's address.

The electric inspection lamp shown in the accompanying drawing consists of a barrel part *A*, a stock *B*, and a slidable trigger *C* held towards the barrel by a coiled spring *D* surrounding a pin *E*. The upper part *F* of the trigger and the underside of the breech part are curved to support the trigger and maintain it in alignment with the barrel. The forward end of the trigger thus forms part of a spring-loaded clip, which is normally urged into the closed position, serrated jaws being shaped to form conjointly an elliptical slot. The barrel carries a lamp-holder *G* and is surrounded by a shade, the holder is wired so that it can be connected to a supply point. When in use the stock of the lamp is grasped and the spring-loaded

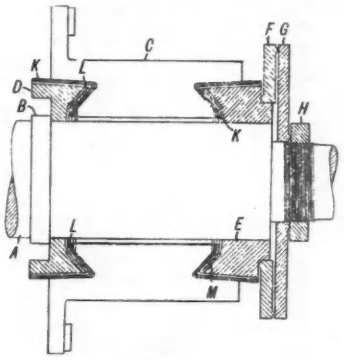


No. 648,227

trigger retracted to separate the jaws sufficiently to allow a part of a motor vehicle or a support to be gripped between the jaws when the trigger is released.—*January* 3, 1951.

648,224. December 23, 1948.—Improvements relating to Commutators for Dynamo-Electric Machines, The Metropolitan-Vickers Electrical Company, Ltd., of St. Paul's Corner, 1–3, St. Paul's Churchyard, London, E.C.4 (*a communication from the General Electric Company, of Schenectady, New York, U.S.A.*).

The invention provides a commutator construction of the spring ring type, which is not subject to limitations when either high peripheral speed or operation at high temperatures is desired. In the drawing the shaft *A* of a dynamo is provided with a shoulder *B*. A number of copper commutator segments *C* are insulated from each other and are held in place by two clamping rings *D* and *E*. Two spring rings *F* and *G* are used to restrain the movable V-ring *E*. By screwing inwards a nut



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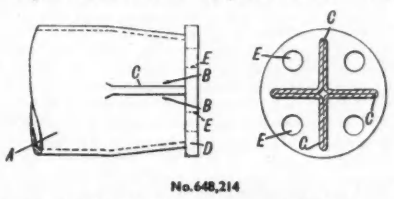
H on the shaft *A* the ring *E* is moved inwards against the commutator segments. The commutator segments are insulated from the V-rings by insulators or mica rings. A metallic shim *K* is cemented to the surface of the mica V-rings to take the effects of any rubbing between the metal and mica rings. In addition, the contact surface of each clamping V-ring is faced with an insert *L* of bearing metal, to reduce still further the friction between the relatively movable parts. When the dynamo is operating under conditions of temperature or speed change so that there is movement between the clamping rings and the commutator bar assembly, movement will take place between the metal shim and the bearing metal rather than on the surface of the mica insulation.—*January* 3, 1951.

STRUCTURAL ENGINEERING

648,214. December 20, 1948.—Improvements relating to Means for Coupling Together Tubular Stress Bearing Elements, Stewarts and Lloyds, Ltd., of 41, Oswald Street, Glasgow, C.1, Scotland, and Gavin Burton Stewart, of the company's address.

The invention comprises a method of manufacturing tubular stress bearing elements by closing the wall of each end portion to form three



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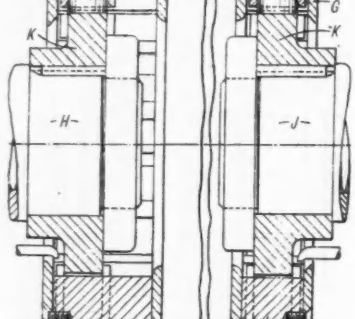
or more longitudinal flutes separated by corresponding ribs, and welding to the end of each deformed portion a coupling flange. Referring to the drawing, the element consists of a tube *A*,

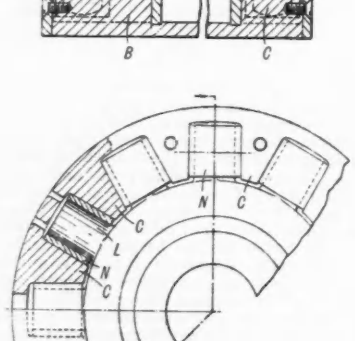
which, at each end, has its wall closed inwardly so as to form four flutes *B*, each subtending an angle of approximately 90 deg. The deformed portions of the tubular wall abut together to form four longitudinal separating ribs *C*. A circular metal flange *D* is welded to this cruciform formation at each end and holes *E* are drilled in the flange equidistant from its centre and midway between adjacent ribs *C*. The flanges *D* and the ribs *C* can be kept wholly within the external circumferential dimensions of the tube itself. The flutes give access to bolts passed through the holes *E* in the abutting flanges of the adjacent tube ends for coupling two tubes together. In a modification, for reinforcement purposes, a liner is inserted at the tube end prior to inward deformation and both tube and liner are deformed.—*January* 3, 1951.

MISCELLANEOUS

647,674. April 28, 1948.—IMPROVEMENTS IN COUPLINGS FOR SHAFTS AND THE LIKE, Vickers-Armstrongs, Ltd., of Vickers House, Broadway, Westminster, London, S.W.1 (*Inventor, William Mitchell*).

The coupling comprises a hollow barrel *A* of cylindrical or polygonal shape and having at its ends concentric parts *B* and *C* each formed with a number of equidistantly spaced groove-like compartments or channels *D* and *E*, so that in end elevation the barrel *A* is formed with a number of inwardly directed segments at their outer and inner ends by two annular rings *F* and *G*, fixed to the



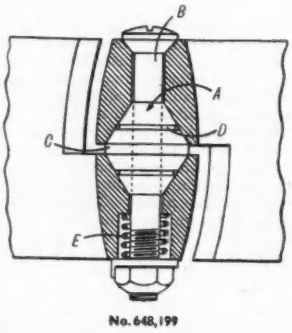


No. 647,674

barrel. Each of the two shafts *H* and *J* to be connected together by the barrel, has at its end a head or cap *K*, from which radiates a number of cylindrical pintles *L* corresponding with the number of compartments *D* or *E* in the barrel. Over the pintles are slipped bearing blocks *N*, which swivel on the pintles. By making one or both sets of the compartments of appreciably greater axial dimensions than the corresponding dimension of the associated block the two shafts can become displaced axially relatively to each other without relative rotation. Thus the swivelling blocks become torque transmitting members with a tangential driving force against the slide walls of the compartments. Means are provided to feed lubricant to the sliding faces of the swivelling blocks and compartments or channels and also to lubricate the engaging surfaces of the pintles and blocks.—*December* 20, 1950.

648,199. December 15, 1948.—IMPROVEMENTS CONNECTED WITH HINGES, Samuel Jack Myers, of "Bayridge," Criccieth, in the County of Cærnarvon, North Wales.

In the accompanying drawing is shown a hinge for use in automobile body construction. The bearing member *A* of double conical form is rotatably mounted on the hinge pin *B*, which serves to secure the two hinge members or heads together. The bases of the conical portions of the



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bearing member are separated by a narrow centre portion *C* and the surfaces of the conical portions may be provided with lubrication grooves *D*. The bearing member may be mounted with a slight degree of play on the hinge pin, which is preferably provided with a compression spring *E* to maintain the hinge members and bearing member in contact and take up wear.—*January* 3, 1951.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

Chemical Society

Thurs., Feb. 1st.—Burlington House, Piccadilly, London, W.1, Reading of Original Papers, 7.30 p.m.

Electric Railway Society

Thurs., Feb. 1st.—Fred Tallant Hall, Drummond Street, London, N.W.1, "Four Inter-Urbans and a Monstrosity," A. A. Jackson, 7.30 p.m.

Illuminating Engineering Society

Wed., Jan. 31st.—SWANSEA GROUP: 4, Northampton Gardens, Swansea, Presidential Address, L. J. Davies, 5.45 p.m.

Thurs., Feb. 1st.—CARDIFF CENTRE: S. Wales Electricity Board, The Hayes, Cardiff, Presidential Address, L. J. Davies, 5.45 p.m.——EXETER GROUP: Agricultural House, Queen Street, Exeter, "Shop Window Lighting," T. S. Jones, 7 p.m.

Incorporated Plant Engineers

To-day, Jan. 26th.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham, "Presentation of a Technical Paper," D. H. Bramley, 7.30 p.m.

Mon., Jan. 29th.—W. AND E. YORKSHIRE BRANCH: The University, Leeds, "Metal Spraying," 7.30 p.m.

Institute of British Foundrymen

Sat., Jan. 27th.—E. MIDLANDS BRANCH: College of Technology and Commerce, The Newarke, Leicester, "Castings for Internal Combustion Engines," C. R. van der Ben and H. Haynes, 6 p.m.——WALES AND MONMOUTH BRANCH: Engineers' Institute, Cardiff, "Report of the Grey Ironfounders Productivity Team," A. Kirkham, 6 p.m.

Wed., Jan. 31st.—LONDON BRANCH: Waldorf Hotel, Aldwych, W.C.2, Films, "Flawless and British," and "And Now," 7.30 p.m.

Institute of Fuel

Tues., Jan. 30th.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1, "Drying Technique," 5.30 p.m.

Institute of Industrial Supervisors

To-day, Jan. 26th.—CARDIFF SECTION: Park Hotel, Cardiff, Annual General Meeting and Section President's Address, 7 p.m.

Thurs., Feb. 1st.—WARRINGTON SECTION: Richard Fairclough School, Warrington, "The Foreman and Time Study," V. N. Picken, 7 p.m.

Institute of Welding

Wed., Jan. 31st.—Institution of Civil Engineers, Great George Street, Westminster, S.W.1, "Continuous Welded Structures, Abbey Works, Port Talbot," W. S. Atkins, 6 p.m.

Institution of Civil Engineers

Tues., Jan. 30th.—Great George Street, Westminster S.W.1, "The Design and Construction of Storage Bunkers and Silos," G. P. Bridges, 5.30 p.m.

Institution of Electrical Engineers

Tues., Jan. 30th.—MEASUREMENTS AND RADIO SECTIONS: Savoy Place, Victoria Embankment, W.C.2, Symposium of papers on "Electrical Meteorological Instruments," 5.30 p.m.

Wed., Jan. 31st.—LONDON STUDENTS' SECTION: Savoy Place, Victoria Embankment, W.C.2, "Synchronous Generator Performance," P. D. Aylett, 7 p.m.

Thurs., Feb. 1st.—Savoy Place, Victoria Embankment, W.C.2, "Standardisation and Simplification in the Electrical Industry," J. T. Moore; "An Organisation for Internal Standardisation in a Large Manufacturing Company," P. J. Daglish, 5.30 p.m.

Institution of Engineering Inspection

Thurs., Feb. 1st.—LONDON CENTRE: Royal Society of Arts, John Adam Street, Adelphi, W.C.2, "Inspection of Engines," E. M. D. Brown, 6 p.m.—N.W. BRANCH: Engineers' Club, Albert Square, Manchester, "Instruments in Industry," A. W. Burrell, 7 p.m.

Institution of Heating and Ventilating Engineers

To-day, Jan. 26th.—MANCHESTER AND DISTRICT BRANCH: Town Hall, Manchester, "Combustion Control," J. E. O'Breen, 6.30 p.m.

Institution of Mechanical Engineers

To-day, Jan. 26th.—Storey's Gate, St. James's Park, S.W.1, Informal Discussion on "Causes of Breakdown in Steam Plant," 5.30 p.m.

Sat., Jan. 27th.—GRADUATES' SECTION: Storey's Gate, St. James's Park, S.W.1, "A Commentary on Some Human and Engineering Aspects of Mechanical Development in the Last Two Centuries," D. F. Galloway, 3 p.m.

Tues., Jan. 30th.—SOUTHERN BRANCH, GRADUATES' SECTION: Municipal College, Portsmouth, "Administration in Engineering," P. K. Digby, 7 p.m.

Fri., Feb. 2nd.—Storey's Gate, St. James's Park, S.W.1, "Industrial Design and its Relation to Machine Design," H. G. Conway, 5.30 p.m.——N.E. BRANCH, GRADUATES' SECTION: Head, Wrightson and Co., Ltd., Eaglescliffe Foundry, Eaglescliffe, near Stockton-on-Tees, "The Overhaul and Repair of Road Vehicles," A. H. Moore, 7 p.m.

Institution of Production Engineers

Thurs., Feb. 1st.—GLASGOW SECTION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "Human Relations in Industry," W. P. Kirkwood, 8 p.m.

Institution of Structural Engineers

To-day, Jan. 26th.—MIDLAND COUNTIES BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, "Some Aspects of the Construction of a Large Modern Tin-Plate Cold Reduction Plant," A. Sutcliffe and G. E. Garrard, 6 p.m.

Fri., Feb. 2nd.—WESTERN COUNTIES BRANCH: College of Technology, Bristol, "A Chapter of Engineering a Century Ago," Andrew Robertson, 6.15 p.m.

Institution of Works Managers

Thurs., Feb. 1st.—BRISTOL BRANCH: Royal Hotel, Bristol, "Foremanship," 7.15 p.m.

Fri., Feb. 2nd.—NOTTS AND DERBY BRANCH: Mechanics' Institute, Nottingham, "Why Nationalised Industry Cannot Be Efficient," L. C. Ord, 7.30 p.m.

Junior Institution of Engineers

To-day, Jan. 26th.—SHEFFIELD AND DISTRICT SECTION: Grand Hotel, Sheffield, "The Erection of a Spirally Guided Gas Holder," R. A. Benson, 7.30 p.m.

Sat., Jan. 27th.—N.W. SECTION: Manchester Geographical Society, 16, St. Mary's Parsonage, Manchester, "A Marine Engineer's First Voyage," W. H. G. Powell, 2.30 p.m.

Fri., Feb. 2nd.—39, Victoria Street, London, S.W.1, Film Evening, "Wonder Rock," introduced by H. Wallace, 6.30 p.m.

Liverpool Metallurgical Society

Thurs., Feb. 1st.—Electricity Service Centre, Whitechapel, Liverpool, "Electro-Deposition for Engineering Purposes," A. W. Hothersall, 7 p.m.

Manchester Association of Engineers

Fri., Feb. 2nd.—Engineers' Club, Albert Square, Manchester, "Planning for Production Efficiency," Sir Claude D. Gibb, 6.45 p.m.

North-East Coast Institution of Engineers and Shipbuilders

To-day, Jan. 26th.—Mining Institute, Newcastle-upon-Tyne, "Electronics in Naval Architecture," L. C. Burrill and A. G. Boggis, 6.15 p.m.

Royal Meteorological Society

Tues., Jan. 30th.—Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2, Symposium of Papers on "Electrical Meteorological Instruments," 5.30 p.m.

Society of Engineers

To-day, Jan. 26th.—17, Victoria Street, London, S.W.1, Address by the New Chairman, J. C. Maxwell Cook, 6.30 p.m.

Society of Instrument Technology

Tues., Jan. 30th.—Manson House, Portland Place, London, W.1, "The Machining of Small Instrument Parts," K. J. B. Wolfe and P. Spear, 6.30 p.m.

BRITISH SCIENTIFIC BOOK EXHIBITION.—An exhibition of scientific and technical books and periodicals, arranged by the British Council, was opened at the Technische Hochschule, Vienna, on January 15th. The exhibition includes about 1300 books and nearly 400 periodicals and is divided into sections on pure and applied sciences and medicine. A separate section contains about two dozen British dictionaries, encyclopædias and other reference works.